TRANSACTIONS

OF

# THE AMERICAN SOCIETY

OF

# HEATING AND VENTILATING ENGINEERS

VOL. IX.

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NINTH ANNUAL MEETING

NEW YORK, JANUARY 20-22, 1903

SUMMER MEETING

NIAGARA FALLS, N. Y., JULY 17-18, 1903

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# THE AMERICAN SOCIETY

OF

# HEATING AND VENTILATING ENGINEERS.

NINTH ANNUAL MEETING.

New York City, January 20, 21, 22, 1903.

## PROCEEDINGS.

### First Session.

The Ninth Annual Meeting of the American Society of Heating and Ventilating Engineers was held in the hall of the American Society of Mechanical Engineers, No. 12 West Thirty-first Street, New York City, January 20, 21 and 22, 1903.

The meeting was called to order on Tuesday, January 20th, at 2.35 P.M., by the President of the Society, Mr. A. E. Kenrick.

Secretary Mackay called the roll, and reported a quorum present.

The President: There being the required number of members present to constitute a quorum, the next business in order is the President's address.

President Kenrick read the following address:

### PRESIDENT'S ADDRESS.

Gentlemen: It is my privilege, as well as my duty, to address you at the opening of this our Ninth Annual Meeting. This Society, which less than eight years ago was small and

weak as a child just come into life, has leaped into vigorous manhood in so short a space of time that it seems almost to have sprung full-fledged from the brains of its founders: possibly there is more in this comparison than at first might appear, for this Society, but lately only a conception in the brains of a few, has attained to a membership of over one hundred and seventy-five heating and ventilating engineers.

This is a cause for congratulation, but it is only *one* of the reasons why we meet to-day under auspicious circumstances; another is that the character of the work done by our members is improving year by year, and the reports of the proceedings of the Society are being sought for by similar societies in different parts of the world; but the most auspicious element of the time is the fact that we are in the midst of great and wonderful achievements in science and engineering, while the opportunities opening before us are simply marvellous in their possibilities.

As heating and ventilating engineers, we may be pardoned if we enquire what relation we bear to what has been done and what remains to be done in the line of the world's progress.

A prominent scientist said that the end of discovery must be about reached, and that there could be no probability that the next age would advance as rapidly as this has done but discovery has followed discovery until, at the present time, we stand aghast and say, what can come next? It is, however, probable that the future will bring many a discovery and application of knowledge far beyond anything we can imagine.

The proper installation of heating and ventilating plants, together with hundreds of other discoveries and inventions of the nineteenth century, were beyond the thoughts of our forefathers one hundred years ago; but I will not detain you by further speculations as to the future triumphs of our profession; that they will be great does not admit of a doubt in view of the past; that they will be more wonderful and important than we can now comprehend is probable from the analogy of history; that they will elevate and ennoble man, lift him out of his present limitations and make him the master where now he is the victim, is certain, because

that has always been the effect heretofore, and because it is the end for which the engineer is commissioned.

This Society is to be a factor in such result. Its every meeting to mingle experiences, to discuss causes, to compare attainments and to encourage research, is a step toward the final achievement when every force in nature and every created thing shall be subject to the control of man.

I congratulate the Society upon the success attained in the past, and trust that the future will bring honor to its cause and to my fellow-members.

The President: The next business in order is the report of the Secretary.

Mr. W. M. Mackay, the Secretary, read the following report:

## REPORT OF THE SECRETARY.

Jan. 20, 1903.

THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Gentlemen: Your Secretary would report a large increase in membership during the past year. At our last annual meeting our membership was composed of 133 Members, 1 Honorary Member, 5 Associates and 4 Juniors, or a total of 143 Members of all grades. During the year we have added 28 Members, 9 Associates and one Junior, one Junior Member has been reinstated, one Junior Member has been advanced to full membership, one Member and one Associate have resigned, and five Members and one Associate have been dropped from the roll for non-payment of dues. Our present membership is 156 Members, 1 Honorary, 12 Associates and 5 Juniors, or a total of 174 Members of all grades, making a net increase of 31 during the past year, in addition to which we have a number of applications to be acted on and voted on after the annual meeting.

The financial affairs of the Society are in a better condition than they have been for some years. At the last annual meeting there was a balance in the hands of the Treasurer of \$80.53 with \$300 owing from the members for dues, and an indebtedness of \$388.09. Feeling that the Society should

not be hampered for lack of funds, a gentleman interested in its welfare made a donation of $100 to the funds of the Society, and our President raised a fund of $300 by voluntary subscription, from the members present at the last annual meeting, to be applied to the general funds of the Society. Two hundred and eighty-five dollars of the amount subscribed has been paid, leaving a balance due of $15. We have received from all sources during the past year, $2,460.04, which, with the balance on hand, made a total of $2,540.57 available.

The expenditures, including accounts of $388.09 left over from 1901, amounted to $2,086.88, leaving a balance in the hands of the Treasurer of $453.69.

There is a balance owing from members for dues and from newly elected candidates for membership for initiation fees and dues and bills for electrotypes; this, with the balance of subscription to Deficiency Fund, amounts to $534. This, with the balance on hand, amounts to $987.69.

We have unpaid bills in connection with the present meeting, and the balance of the Secretary's account amounting to $162.72, so that with the amount on hand and owing from members and others, deducting the bills payable, $162.72, leaves a balance of $824.97.

The six members dropped from the rolls during the year owed $30 each, or a total of $180.

The Secretary's expenses for the year, including stenographer, clerk hire, postage, rent of post-office box, expenses in connection with the summer meeting, expressage, etc., amount to $395.60.

The 1902 proceedings have been edited and placed in the printer's hands with the exception of seven corrected discussions, which have not been returned by the members. This discussion will be furnished and the proceedings published as soon after this meeting as possible, and will be forwarded to the members during the next sixty days. The cost of the editing and printing will amount to about $700.

The Proceedings of the Society are sent free to thirty-five of the leading colleges, engineering and architectural societies, and we have standing orders for the Proceedings as printed from two additional public libraries and one college.

The Society held a summer meeting at Atlantic City, June

16, 1902; the papers presented being received too late to be printed were read from the manuscript. All the papers to be presented at this meeting (with the exception of one), while received late, have been printed and forwarded to the members.

Respectfully submitted,

W. M. Mackay, Secretary.

On motion of Mr. Jellett the report was accepted and ordered spread on the minutes.

The Secretary then read the Treasurer's report as follows:

REPORT OF THE TREASURER.

New York, Jan, 20, 1903.

| | | | |
|---|---|---|---|
| Balance on hand Jan. 21, 1902 | | $80 53 | |
| Cash received since Jan. 21, 1902: | | | |
| Dues | $1,505 19 | | |
| Initiation fees | 420 00 | | |
| Pin badges | 5 00 | | |
| Electrotypes | 9 85 | | |
| Proceedings | 135 00 | | |
| Donation | 100 00 | | |
| Subscription to Deficiency Fund | 285 00 | $2,460 04 | |
| | | | $2,540 57 |
| Disbursements: | | | |
| Treasurer, collections, stamps, etc | | $5 43 | |
| Secretary's account, 1901 | | 288 09 | |
| Mechanical Engineers' Rooms | | 65 00 | |
| Stenographer, annual meeting | | 80 00 | |
| Certificates of Membership | | 15 00 | |
| Bormay & Co., cuts | | 58 10 | |
| Bureau of Engraving, cuts | | 41 93 | |
| Cut Cabinet | | 17 81 | |
| Letterheads | | 21 75 | |
| Editing 1901 Proceedings | | 100 00 | |
| Stenographer, summer meeting | | 75 00 | |
| Carried foward | | $768 11 | |

| | | |
|---|---|---|
| Brought foward | $768 11 | |
| J. J. Little & Co., balance 1900 proceedings | 100 00 | |
| J. J. Little & Co., advance papers, 1902 meeting | 99 22 | |
| J. J. Little & Co., 1901 Proceedings | 643 51 | |
| Treasurer's bond | 15 00 | |
| Printing | 95 50 | |
| Pin badges | 15 00 | |
| Secretary's account, 1902 | 350 54 | $2,086 88 |
| Balance on hand | | $453 69 |

JUDSON A. GOODRICH, Treasurer.

On motion of Mr. Connolly the report of the Treasurer was accepted and ordered spread upon the minutes.

The President: The report of the Board of Governors is the next in order.

The report of the Board of Governors was read by Prof. Kinealy, as follows:

## REPORT OF THE BOARD OF GOVERNORS.

Annual Meeting, 1903.

Gentlemen: Your Board of Governors met and organized January 23, 1902, appointing a Committee on Finance, Membership, and Publication, and electing an Executive Committee of New York City members. The various committees have given careful attention to their duties, and the Board has held four meetings during the year.

We are able to report a substantial increase in membership and the financial affairs of the Society are in a good condition.

There are still several hundred dollars owing from members for back dues, and we would urge a prompt payment of these and the annual dues, which will become due on February 1, 1903.

The 1902 Proceedings have been edited and placed in the printer's hands, and will be completed and forwarded to the

members as quickly as possible. A revised list of members, corrected to November 1, 1902, together with the Constitution and By-Laws, has been published and forwarded to the members.

As per resolution at the summer meeting, the Board of Governors has been in correspondence with the Executive Committee of the Carnegie Institution, Washington, D. C., requesting that a laboratory of research and experiment in connection with heating ventilation and cooling be considered, in connection with their Institution, and we have the assurance of the Executive Committee that our request will receive consideration at their meeting this month.

While the papers to be presented at this meeting were received late, they have been edited, cuts prepared, and have been printed and forwarded to the members, with the exception of a paper from R. C. Carpenter, which has not been received.

Your Board arranged for a summer meeting at Atlantic City on June 16, 1902, which was largely attended, and resulted in a number of applications for membership being received.

The papers presented at the summer meeting were not received in time to be printed. They were read from manuscript and will appear in the annual Proceedings.

Respectfully submitted,

Alfred E. Kenrick, Chairman;
John Gormly, Vice-Chairman;
J. H. Kinealy,
Wm. Kent,
R. C. Carpenter,
C. B. J. Snyder;
Wm. M. Mackay, Secretary.

On motion the report of the Board of Governors was accepted and ordered spread on the minutes.

The President: The next order of business is the reports of Standing Committees. First is the Committee on Compulsory Legislation, of which Mr. William M. Mackay is chairman. Has that committee any report to make at this time?

Mr. Mackay read the following report:

## REPORT OF COMMITTEE ON COMPULSORY LEGISLATION.

Annual Meeting, 1903.

Your Committee would report that efforts have been made during the past year to secure legislation to compel the proper ventilation of public buildings and schoolhouses in the States of Pennsylvania, Maryland, Michigan, Illinois and New York. It has been impossible to secure action in Pennsylvania and in Michigan, as the Legislature in those States have not been in session for the past two years. A bill is now being prepared by the member of our Committee from Illinois, to be presented at the coming session of the Legislature, and we are encouraged by those through whom this bill will be presented to hope for its passage.

In New York State your Committee was ably assisted by C. B. J. Snyder, Superintendent of School Buildings, Department of Education, City of New York, a member of our Society and one of our Board of Governors, who prepared a bill to provide for proper sanitation, ventilation, and protection from fire of schoolhouses and other public buildings in the State of New York. This bill was presented in New York State Assembly on March 17, 1902, by Mr. Woody, a member from Brooklyn, City of New York, and while every effort was made to secure the adoption of this bill, the late date of its presentation prevented its adoption, although all who have seen and read the bill were in favor of it. We submit a printed copy of the bill with this report.

Mr. Snyder, representing our Society, addressed the New York State Association of School Superintendents at Albany last October, on this subject, and as a result they have become interested to such an extent that they have prepared a bill, largely along the lines of the Woody bill, prepared by Mr. Snyder, which is being presented at this session of the New York State Legislature.

Your Committee have assured the School Superintendents' Association that they will have the earnest support of our Society and its individual members in securing the adoption of this bill, and as their Association covers every county, city,

town, and village in the State, we have every hope that sufficient influence will be brought to bear with the State Legislature to insure its adoption.

Respectfully submitted,

WM. M. MACKAY, Chairman;
HENRY ADAMS,
ANDREW HARVEY,
T. J. WATERS,
B. H. CARPENTER.

On motion the report was accepted and ordered spread on the minutes.

STATE OF NEW YORK.

No. 1732. Int. 1266.

IN ASSEMBLY,

*March* 17, 1902.

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Introduced by Mr. WOODY—read once and referred to the committee on PUBLIC HEALTH.

AN ACT

TO PROVIDE FOR PROPER SANITATION, VENTILATION AND PROTECTION FROM FIRE OF SCHOOLHOUSES AND OTHER PUBLIC BUILDINGS.

*The People of the State of New York, represented in Senate and Assembly, do enact as follows:*

Section 1. Every schoolhouse and other public building hereafter erected in a city or incorporated village within this State shall be provided with a reasonably sufficient number of proper water closets, lavatories, earth closets or privies, for the use of persons occupying or admitted to such schoolhouse or public building; shall be kept clean and free from all noxious smells or gases arising from any closet, drain, privy or other nuisance and shall be provided with proper means for ventilation in such manner that there shall be at all times a sufficient supply of pure air therein.

§ 2. Prior to the erection or construction of any schoolhouse or public building, the person or persons or corporation owning the same shall submit a full and complete copy of the plans, together with a statement in writing of the proposed building, which statement must contain a clear and comprehensive description properly sworn to by said owner or authorized representative of those portions of the proposed work which deals with the sanitation, ventilation and protection from fire of said proposed buildings. Such details, statement and copy of the plans shall be submitted to and filed with the department of buildings, health board or other officer or officers having like jurisdiction, within an incorporated city or village where said buildings are about to be erected, and in all other places, including any city or incorporated village not having an officer or officers exercising jurisdiction as a board of health or health officer, such detail statement and copy of plans shall be submitted to and filed with the state board of health. No such schoolhouse or other public building shall be erected or constructed until such specifications and plans shall have been approved in writing by the department of buildings, board of health or officer exercising jurisdiction thereof, to whom such plans shall be submitted as required by this act. The sanitation, ventilation and protection from fire of every such schoolhouse or other public building as provided by this act, shall be subject to the inspection of such board of health or other officer exercising like jurisdiction during the progress of such erection or construction, by its or his agents or servants, and shall conform in all things to the reasonable requirements of such board of health or other office of like jurisdiction.

§ 3. Every such schoolhouse and public building for which a detailed statement and plans are filed as provided by this act shall be ventilated in such a manner that the quantity of foul or vitiated air exhausted or removed shall be positive and independent of atmospheric changes, and shall not be less than fifteen cubic feet per minute for each person; and the quantity of fresh air admitted shall be not less than fifteen cubic feet per minute for each person than such schoolroom and public building can accommodate.

§ 4. It is further made the duty of such department of

buildings, board of health, health officer, or other body or person having jurisdiction, to have such inspections made from time to time as may be deemed necessary, to see that the said schoolhouses and public buildings as are built in compliance with this act are kept and maintained in a proper sanitary condition and that the provisions of this act are complied with. Should said inspection determine the fact that the provisions of this act are not being complied with, said department of buildings, health board or health officer, or other officials exercising jurisdiction shall at once issue a written order to the trustees, corporation or public officers having charge of, owning or leasing said schoolhouse or public building, requiring the immediate correction of the violation found, giving such time for their correction as may be deemed best for the public welfare.

§ 5. All schoolhouses and public buildings for which plans and a detailed statement shall be filed and approved, as required by this act, shall provide that all halls, doors, stairways, seats, passageways and aisles and all lighting and heating appliances and apparatus shall be arranged to facilitate egress in cases of fire or accident and to afford the requisite and proper accommodations for public protection in such cases. All exit doors shall open outwardly and shall, if double doors be used, be fastened with movable bolts operated from the inner face of the door. No staircase shall be constructed with wider steps in lieu of a platform but shall be constructed with straight runs, changes in direction being made by platforms; the rise of said staircases shall not exceed eight and one-half inches to a step and shall not be less than nine inches tread, exclusive of the nosing. Handrails shall be provided on either side of all staircases. No door shall open immediately upon a flight of stairs, but a landing at least the width of the door shall be provided between such stairs and such door. Every public building or place of assemblage accommodating five hundred persons shall have at least two exits of not less than five feet in width and for every additional one hundred persons or portion thereof to be accommodated in excess of three hundred, an aggregate of twenty inches additional exit width must be allowed. The stone or brick work of the smoke flues for all boilers and furnaces shall be at least eight inches in thickness

and shall be properly capped with stone or other similar material; the inside four inches of said flues shall be of fire brick laid in fire mortar for a distance of twenty-five feet in any direction from the source of heat. All smoke flues other than for boilers or furnaces shall be lined on the inside with cast iron or well burnt clay or terra cotta pipe, made smooth on the inside, from the bottom of the flue or throat of the fireplace and carried up continuously to the top of the flue, each section of the pipe to be built in as the flue or flues are carried up, each side of each flue to consist of not less than four inches of brickwork, well bonded together; no flue shall be started or built upon any floor or beam of wood, neither shall any floor, beam or joist be placed within six inches from the interior of a flue and no wood casing, furring or lath shall be placed against or cover any smoke flue or metal pipe used to convey hot air or steam, but in the case of flues for hot air or steam this shall not prohibit the covering of said flues with metal lath and plaster with an air space of seven-eighths of an inch and the placing of the woodwork directly thereon. No stove pipe shall be placed nearer than nine inches to any lath and plaster or board partition, ceiling or woodwork and in the case of furnaces such distance shall be from fifteen to thirty inches unless properly protected with metal, but in no case shall the distance be less than twelve inches. No vertical hot air pipe shall be placed in any stud partitions or in a wood enclosure unless it be at least eight feet distant in a horizontal direction from the furnace. Steam or hot water pipes shall not be placed within two inches of any timber or woodwork. In the construction of fire-escapes the balconies shall be made so as to be easily accessible from the different floor levels and the rails thereof shall not be less than thirty inches in height. No iron ladders shall be used in connection with any fire-escape, but there shall be provided iron stairways with a tread of not less than seven inches and a rise of not more than nine inches, protected with proper iron hand rails.

§ 6. The word schoolhouse as used in this act, shall be taken and deemed to mean any building in which public or private instruction shall be given to not less than ten pupils at one time; and the words public building as used in this act shall be taken and deemed to mean any building or premises

used as a place of public entertainment, instruction, resort or assemblage, or for the purpose of transacting public business of any kind or nature whatsoever, when there shall be more than ten persons in any such building at any one time. Provided, however, that this act shall apply only to cities and incorporated villages.

§ 7. Any violation of this act or failure to comply with its provisions by any school committee, public officer or corporation or other persons whatsoever shall be a misdemeanor.

§ 8. This act shall take effect July first, nineteen hundred and two.

The President: The next committee is the Committee on Uniform Contract and Specifications, of which Mr. Jellett is chairman. Is that committee ready to report?

Mr. Jellett read the following report:

## REPORT OF COMMITTEE ON UNIFORM CONTRACT.

New York, January 20, 1903.

*To the American Society of Heating and Ventilating Engineers.*

GENTLEMEN: Your committee, appointed to prepare a uniform contract covering the installation of heating and ventilating plants, have given the matter very considerable study during the past year, and present for your consideration a form of contract, together with general conditions covering the specifications, which seem to them to meet the conditions prevailing throughout the country generally better than any form that we know of.

After discussing the matter very freely, and getting opinions from different parties who have had experience in such matters, we have reached the conclusion that it is very much better to make the contract itself short, covering only the names of the parties, what they agree to do, when they agree to start and complete the work, the amount of money to be paid, how it is to be paid, and the question of liens, and that all other matters usually placed in the contract should be placed in the general conditions covering the specifications. When a set of specifications are sent out for bids, these general conditions should be attached to the specifications, in

order that the contractor bidding on the work shall know at the time of bidding under what conditions the work will have to be executed. The committee feel that in the past considerable trouble has been created by want of such knowledge on the part of the contractor, at the time the bids were being made.

For example, many specifications are sent out, and nothing whatever is said about a bond. When the estimate is accepted and the bidder is asked to sign the contract, he is met with a request for a bond, sometimes in quite a large sum. This means an expense to him usually of one per cent., an item which he had not included in his estimate, and which it is right the owner should pay, as the owner who requests a bond from the contractor, is really asking for insurance that the contract shall be completed within a specified time and in a definite manner, etc., and he should pay for such insurance.

Again, the question of fire insurance comes up. The owner frequently asks the contractor to carry the insurance, or part of it. There is no reason why the contractor should carry the owner's insurance unless the owner is paying for it.

The drawings also should be identified, and as they accompany the specifications, they should be detailed in the general conditions of the specifications.

Again, the specifications and plans should not be returned to the architect or owner before the certificate for final payment is given, because if returned before all questions are settled, and a dispute should arise afterward, the contractor has given up his principal evidence in the matter and is practically helpless.

If it is the intention to ask the contractor to sign a contract waiving his right to lien, then he should be given notice of this intention when asked to bid, so that before entering into a contract containing a clause to the effect that he will have no right of lien, he will be in a position to demand security, or other satisfactory guarantee of payment, before he signs the contract.

Your committee, therefore, have placed under the head of general conditions to be attached to the specifications many of the conditions that are usually found in the contract, with the idea that the contractor should be in possession of this in-

formation when bidding, and the contract is so drawn as to include these items as an integral portion of same.

We would ask that the Society give this matter the careful consideration it demands. If the contract and general conditions are approved by the Society, then we would suggest that the National Association of Master Steam and Hot Water Fitters also be asked to pass upon the contract, and if they approve of it, across the face of the contract should be printed the fact that this form is approved by both bodies, just as the uniform contract is approved by the National Institute of Architects and by the National Association of Master Builders.

The contract and conditions presented herewith have been submitted to an able attorney, who has passed on the legal questions involved, and who advises that the strongest form of contract is the one that protects the rights of both parties; that if our Society should draw a contract that would apparently give the owner greater protection than the contractor, or the reverse, such a contract, no matter how strong it seems to be, is very much more easily broken than one that fairly protects the interests of both, and this advice your committee have followed in drawing this contract. Some of our members who are contractors may object to certain clauses, thinking the owner's position is too strongly protected; others, who are consulting engineers, may think that the engineer's or architect's authority is not as strong as it should be, but your committee believe that the contract as drawn is a fair one, and would recommend the Society to adopt it.

Respectfully submitted,

STEWART A. JELLETT, Chairman.
H. J. BARRON,
WILLIAM H. MCKIEVER,
R. P. BOLTON,
F. A. WILLIAMS,
Committee.

The President: Gentlemen, you have heard the report of the Committee on Uniform Contract and Specifications. What action will you take on the report at this time?

Mr. Connolly: I move that it be laid over and made the special business for to-morrow afternoon. (Carried.)

The President: Next in order is the report of the Committee on Standards, of which Prof. Kinealy is chairman.

Professor Kinealy: The Committee on Standards has no report to make other than to submit to the Society the code which it submitted at the last annual meeting. No change has been made in this code, and no suggestion has been received except one from Mr. Gormly, of Philadelphia, which was embodied in a paper read by him at the summer meeting. This suggestion of Mr. Gormly's was that some time of making a test should be specified in the code. Now, the committee did not see how they could specify a particular time, so that the code has not been changed at all, and we simply submit this code to you exactly as it was last year. [See page 347.]

In addition to the report of the code I have a report here which I was asked to submit by vote of the Society. It is a report of a special committee appointed to consider the relation of grate area in heating boilers to the direct radiating surface in buildings. The special committee consists of Mr. James Mackay, Mr. J. A. Gorton and Mr. A. H. Hamlin. For some reason or other this Society voted that this committee should report to the Committee on Standards, and I have the report, which I will read.

The report was read by Professor Kinealy, as follows:

## REPORT OF SPECIAL COMMITTEE ON THE RELATION OF GRATE AREA IN HEATING BOILERS TO THE DIRECT RADIATING SURFACE IN BUILDINGS.

The conditions met with in house-heating engineering are so complicated in comparison with power engineering that many allowances must be made in forming the base of operations.

That is, we must consider lack of attention to the house-heating boiler, variation in quality of fuel, quantity of fire, construction of the building, exposure, distribution of the radiating surface, etc.

The capacity of the boiler must be sufficient to overcome these difficulties in order to be accepted as satisfactory, and it has been the endeavor of this committee to determine a rule or rules by which the several component parts of the boiler

may be definitely prescribed in order to arrive at the relation between its area of grate and the quantity of radiating surface it is to carry.

For example, let us assume that the boiler shall be intelligently operated, that the quality of fuel is good, in fact all conditions favorable—then we are extracting from the coal an average of 14,000 heat units per pound, equal to the evaporation of 14.5 pounds of water from and at 212 degrees, and since one square foot of direct steam radiation gives off 260 units of heat per hour in a room at 70 degrees F., we have from one pound of coal sufficient heat to supply 53.8 square feet of radiation for one hour.

Making the customary deductions for loss of heat by radiation at the boiler, for loss in maintaining draught, for loss from friction in mains, risers and fittings, for loss due to unconsumed fuel and from other sources, we are left with only 50 per cent. of the heat delivered to the radiator; this reduces the quantity of radiating surface to 26.9 square feet per pound of coal per hour.

Assume that a certain building should have, according to our best means of determining, 3,750 square feet of direct steam-radiating surface, we should then require the consumption of 140 pounds of coal per hour to maintain a temperature of 70 degrees F. inside with a zero temperature outside.

Allowing 6 pounds of coal per square foot of grate per hour, for slow combustion in low-pressure cast-iron boilers, gives us $23\frac{1}{3}$ square feet of grate (or 3,360 square inches) for a plant of 3,750 square feet direct-radiating surface or 1.1 square feet surface to 1 square inch of grate, under the best conditions.

To obtain the above result we have this fundamental formula:

$$G = \left(\frac{R}{1.1 \times 144}\right) \qquad (1)$$

where G represents grate area in square feet; R represents radiating surface in square feet.

So far we have dealt with a cast-iron steam boiler of the upright sectional push-nipple type, portable setting and standard cast-iron direct radiation only.

The necessary deductions should now be considered to cover

existing conditions, and for this let k represent the coefficient, its value being unity in formula No. 1. Take for example a stone building of 24-inch walls, normal glass area and exposure, and its construction of the best throughout, with first quality of anthracite nut coal being used; the factor of safety not being considered, simply providing for the very smallest boiler for the building.

Then we have

$$G = k\left(\frac{R}{1.1 \times 144}\right) \tag{2}$$

Values for k should be determined for the several kinds and qualities of coals and other fuels used in house-heating boilers, for the several materials of building construction, for degree of exposure, etc. These values, however, can only be satisfactorily and safely derived from numerous tests. In general practice the relative value of anthracite nut and pea is 1 to 3. Inserting this value for k in No. 2 we have

$$G = 3\left(\frac{R}{1.1 \times 144}\right) \tag{3}$$

as the grate area necessary for burning pea coal.

For water heaters subject to the same conditions formula No. 3 becomes

$$G = 3\left(\frac{R}{1.1 \times 144}\right) 0.65 \tag{4}$$

The percentage of error in 4 may be eliminated in accordance with practice by decreasing the grate area 10 per cent.; then we have

$$G = 3\left(\frac{R}{1.1 \times 144}\right) 0.585 \tag{5}$$

Other questions of importance enter into the consideration of formula No. 2, although they are not incorporated in this subject as handed to the committee. They are: the type of boiler, the boiler-heating surface, the boiler-flue area, and the size and construction of the chimney. How do they affect the relation between G and R?

We have not considered them in this report, but they should be taken into account on further development of formula No. 2.

We urgently recommend a series of tests to determine the possible values of k to cover conditions hereinbefore enumerated.

Respectfully submitted,

A. S. HAMLIN, Chairman.
JAS. MACKAY,
J. A. GORTON.

The President: You have heard the report of the Committee on Standards, also the report of the Special Committe appointed one year ago. I think perhaps it would be well to take the vote on the acceptance of these reports separately, and I will take the liberty to ask what action you will take on the report of the Committee on Standards?

Mr. Barron: I move that the report be received and the committee continued. (Carried.)

The President: Now, in regard to the report of the Special Committee appointed at the meeting one year ago, which report we have just heard from the Committee on Standards, what action will you take in regard to that report?

Mr. Jellett: I move that the report be accepted with the thanks of the Society. (Seconded.)

Mr. Rockwood: I would like to ask when the discussion of these reports comes in?

The President: The motion having been made and seconded, the report of the committee will be open for discussion at the present time. Perhaps the report of the committee might be accepted with a motion that the discussion of this report be taken up at some future meeting.

Mr. Jellett: It has always been understood, I think, in our Society, that reports when accepted are open for discussion at any time during the session, because it is impossible to satisfactorily discuss a report of this kind until after we have had an opportunity to study it.

Professor Kinealy: Mr. President, this report, which it was my duty to submit, seems to me to require further consideration on the part of this same committee. The committee, you notice, has submitted a number of formulas, and the committee says, "Other questions of importance enter into consideration of formula No. 2, although they are not incorporated

in this subject as handed to the committee. They are the type of boiler, the size of the flue area and the size and construction of the chimney." Then the committee asks, "How do they affect the relation between G and R?" I should like to see this same committee continued and see if they cannot answer the question which they have asked. This is really, I think, a preliminary report, and therefore I should like to see the committee thanked and asked to do some more work.

Mr. Jellett: I will add to my motion that the committee be continued. (Carried.)

The President: The Committee on Tests, of which Mr. A. A. Cary is chairman, is next in order. I do not see Mr. Cary Is any other member of the committee present to make any report at this time?

I believe that completes the list of reports of standing committees. Now come the reports of the special committees. There is a committee of which Mr. Jellett, I believe, is chairman, on the Relation Between the Engineer and the Architect. Has that committee anything to say at this time?

Mr. Jellett: Nothing.

The President: The next is the Special Committee in regard to our tenth annual meeting, of which Mr. Chew is chairman.

Mr. Barron: That committee held one meeting. All they can do is to report progress. I do not think at this time that it would be advisable to go into the details of the suggestions made. It can be taken up at some other time.

On motion Mr. Barron's statement was accepted.

The President: The next order of business is the appointment of tellers to open, sort and count the ballots for the election of officers for the ensuing year. I will appoint Mr. William H. McKiever, Mr. H. J. Barron and Mr. George I. Rockwood as tellers.

The President: Is there any new business to come before the Society at this time?

Mr. Jellett: There is one thought that I have in mind; I do not know whether it is time to present it or not, and that is, after hearing of the satisfactory financial condition of the Society, whether the old suggestion that I made some two or three years ago, should not come up now into life, that this Society should arrange for a quarterly or monthly publication,

to answer the questions of our members on engineering subjects affecting heating and ventilation, and whether we have as yet reached the financial position where we can secure for such a purpose the services of some young man who has had editorial training. The idea is that our members who have questions they wish to have answered, could forward them and have the questions and answers printed and sent to all the members, so that all would benefit by the information.

The President: Do you incorporate that in a motion?

Mr. Jellett: It is a suggestion, and when the Society reaches the financial position to warrant it I shall present the suggestion again. I have not digested that report sufficiently to be sure of my ground, but I think the question could be taken up at the session, and if the Society is in a financial condition to warrant it, I think the Board of Governors should be authorized to take the step. I make the motion—to bring the subject up for discussion—that if the financial condition of this Society warrants it, the Board of Governors take up the question of issuing either a quarterly or monthly pamphlet or bulletin in which shall be answered questions connected with the business of heating and ventilating.

Mr. Harvey: I support that motion simply to ask a question of Mr. Jellett—what he would consider to be a financial condition that would warrant that.

Mr. Jellett: My own judgment is that a thing of that kind could be started and run for say $50 a month, possibly for less. I do not know what it would cost for printing, but I think some arrangement could be made by which we could secure the services of a young man. It would be necessary that it should be a small publication to start with. The circulation of it would not be very extensive. If it were quarterly, of course it could be more of a publication. It is a matter which would bear considerable discussion. I have never gone into the details of the cost of it, from the fact that the Society has never been in a position to undertake it, but I believe the Board of Governors should investigate that matter, and if we published only an eight-page pamphlet we could answer a good many questions on those eight pages. I think it is a matter which should be given careful consideration. We have some men in our Society who are connected with

engineering journals, and have training in that particular direction, and they could give us this information, I think. The Board of Governors certainly know from the outlook now how to approximate their expenses for the ensuing year. The man employed could be in the position practically of the Society's secretary, or in an editorial position. The cost of that part of the work would be, as I take it, not very great. The printing and publishing would be the largest item, and I believe it would be of great benefit to this Society in increasing its membership if information of this kind was spread among the members much more freely than it is at the present time. I think it is a subject that is well worth serious consideration by our Society.

The President: Perhaps our secretary, Mr. Mackay, can give us some data in regard to the cost.

Secretary Mackay: Mr. President, I do not know that I can enlighten you much more than Mr. Jellett has on the cost. I am heartily in favor of the motion which Mr. Jellett makes, when the Society is in a position to afford it, and I wish it had been in such a position before this, because it would be an incentive for advancing the interests of the Society. But I am afraid that the present financial condition of the Society, good as it is, would prevent us from considering it for at least another year. While we have on hand, and owing to the Society for dues, between eight and nine hundred dollars, all of that will not be collectible, and the amount that will be collectible and on hand would about pay for last year's Proceedings. That would allow us to start 1903 with perhaps a surplus of fifty or a hundred dollars and all back indebtedness paid, and the Proceedings, which have always been one year behind up to date could be ready, for 1903, immediately after the summer meeting, so that the members would have the Proceedings in the fall instead of after another meeting, and it would seem to me that unless there are more funds in sight than we can depend upon from our present membership, the incoming Board of Governors will have all that they can do to handle the affairs of the Society along the present lines and to get these two books before the members before the close of the year. I do not wish to throw cold water on Mr. Jellett's suggestion or motion, because I believe it is a good

thing and something which we ought to have had before this. We are to be congratulated on getting out of debt. It has not been altogether the funds of the Society that have helped us out of debt. You must bear that in mind. There was $400 donated to this Society which has put us on a good, financial basis, and we do not want to undertake anything that we cannot carry through until we have funds ahead to assure success. I believe that $50 a month would be a light view of the expense of such a publication as is suggested. I believe that when it is properly done it will cost about a thousand dollars a year, and I hope that some day the Society will be able to undertake it, and that that will be soon.

The President: Is there any further discussion of this subject? If not, I will put the motion as made by Mr. Jellett.

The motion as made by Mr. Jellett was read and unanimously carried.

The President: Is there any other new business?

Mr. Switzer: Under the head of new business there is a matter that I was requested to bring before the Society at this time in relation to auxiliary or local branches being organized in the various remote sections, for instance, of the West, of members of this Society, whereby they would have stated meetings themselves and discuss the conditions pertaining to heating and ventilating at periods suitable to themselves, and to discuss also the papers that are read at the annual meeting of the Society. This is desirable largely by reason of the fact that many of the members are unable to attend these annual meetings. In remote sections of the West—for instance, the Pacific Coast, Chicago, Northwest and Southwest points—the question has been discussed whether this Society would sanction a movement in that direction, that would enable them to bring up various matters and subjects from time to time, and also to elect delegates to represent those local sections at the annual meetings; preparing papers sufficiently in advance to bring about a more active interest, and also to increase the membership of the Society of Heating and Ventilating Engineers. I would like to have the matter discussed and some expression given on the subject.

The President: Your idea would be the forming of societies

in remote parts of the country and having them subservient to this Society?

Mr. Switzer: Members of this Society being privileged to gather locally and organize branches of the Society. Not the organization of a new society or anything of that sort. Take, for instance, a radius of two hundred miles of Chicago, the same way with Minneapolis, St. Paul, Duluth, Kansas City, St. Louis, San Francisco, and the Pacific Coast cities—they could have stated periods for their meetings to take up topics relating to heating and ventilation and the work of the parent Society, but with the prime object in view of increasing membership. The expense, also, might be borne partly by the members who gather together to send delegates to these annual meetings; by this means greater interest would be induced in those different sections where the province of heating and ventilating engineers is growing very largely and where they do not have an opportunity to get the information presented at these annual meetings. If members in these sections can have representatives attend the annual meetings and report back at their stated meetings, a greater interest in the Society would be shown, and there would be an increased membership and a greater benefit derived from these meetings and the meetings of the parent Society.

The President: Have you any motion to make along those lines at this time?

Mr. Switzer: I would make a motion that the matter be taken up by the Board of Governors, with action of that sort in view, favoring and advocating local branches in remote sections.

The President: Is that motion seconded?

Mr. Harvey: I would like to ask the gentleman if he means the Board of Governors should have full power to act, without the consent of the Society?

Mr. Switzer: I would suggest that the matter be entirely left in the hands of the Board of Governors to use their discretion in the matter. I feel that it is an obligation we owe to members of the Society, located at remote points, to present this subject here. I would state that my duty has been accomplished in presenting it, and I would like to see the

matter favorably considered. I think this board would be the proper authority to act on this question.

Mr. Snyder: I second Mr. Switzer's motion.

The President: You have heard the motion, is there any discussion on the subject?

Mr. Connolly: I move an amendment that Mr. Switzer be appointed a committee of one to submit a concrete scheme to the Board of Governors, and that Mr. Switzer have his report ready for the Board of Governors before the adjournment of this meeting. (Seconded.)

The President: Those in favor of adopting the amendment offered by Mr. Connolly will manifest it by saying Ay; contrary minded, No. It is not a vote. Then we return to the original motion.

Mr. Snyder: The architectural societies found that the only way in which they could succeed was by forming a parent society and having chapters in various parts of the country. This matter has never occurred to me before, but I would move an amendment to the effect that the matter be referred to the Board of Governors who shall, at the next meeting, present a report thereon regarding such amendment of the bylaws as in their judgment they might deem wise or necessary to carry such scheme into effect provided they deem it advisable. (Seconded.)

The President: Do you accept that amendment, Mr. Switzer?

Mr. Switzer: I do, sir.

The motion was put and carried.

The President: Anything further, gentlemen?

Secretary Mackay: Under the head of new business I would announce the names of the newly elected members since the last meeting:

NEWLY ELECTED MEMBERS ANNOUNCED AT ANNUAL MEETING, JANUARY, 1903.

| | | |
|---|---|---|
| STEPHEN G. CLARK | New York | Member |
| LOUIS J. COBEY | Poughkeepsie, N. Y. | " |
| FRANK A. DWYER | Amsterdam, N. Y. | " |
| JOHN O. GALLOUP | Battle Creek, Mich. | " |

| | | |
|---|---|---|
| AUGUST GEIGER | Philadelphia, Pa. | Member |
| WILLIAM NELSON HADEN | Trowbridge, England | " |
| JOHN F. HALE | Chicago, Ill. | " |
| HARRY H. HELLERMAN | Philadelphia, Pa. | " |
| J. GEORGE KLEMM, JR. | Philadelphia, Pa. | " |
| DENIS J. MALONEY | New Haven, Conn. | " |
| WILLIAM McGONIGAL | Mt. Vernon, N. Y. | " |
| GEORGE W. SCOTT | Chicago, Ill. | " |
| EDWARD L. STOCK | N. Tonawanda, N. Y. | " |
| CESAR TERAN | New York | " |
| HUGO G. T. THEORELL | Stockholm, Sweden | " |
| JAMES G. GRANNIS | San Francisco, Cal. | Associate |
| FREDERICK W. SMITH | Dunkirk, N. Y. | " |
| STEPHEN W. ROBINSON | London, England | " |
| EDWARD E. McNAIR | Buffalo, N. Y. | " |

The President: Is there anything further under the head of new business? Perhaps a motion to adjourn would be in order.

On motion, the meeting adjourned at 3:45 P. M.

## SECOND SESSION.

The meeting was called to order on Tuesday evening, January 20th, 1903, at 8:20 o'clock, President Kenrick in the chair.

The President: The first paper to be read this evening is "Temperature Regulation," by Prof. J. H. Kinealy, a member of the Society.

Prof. Kinealy read the paper. It was discussed by Messrs. Joslin, Barwick, Jellett, and Connolly.

Mr. McKiever then presented the report of the tellers as follows:

### REPORT OF TELLERS.

New York, January 21, 1903.

Gentlemen: Your committee appointed to act as tellers of election, beg to submit the following report:

The total vote cast was 94, of which 87 were counted and 7 were defective. The defective ballots consisted of ballots

which had been enclosed without the name of the member on the outside of the enclosing envelope, ballots on which members had neglected to mark their choice of candidates, and ballots which were not enclosed in a double envelope.

The distribution vote for officers was as follows:

PRESIDENT.

| | | |
|---|---|---|
| H. D. Crane | Cincinnati, Ohio | 48 |
| Andrew Harvey | Detroit, Mich. | 38 |

FIRST VICE-PRESIDENT.

| | | |
|---|---|---|
| William Kent | Passaic, N. J. | 60 |
| C. M. Wilkes | Chicago, Ill. | 27 |

SECOND VICE-PRESIDENT.

| | | |
|---|---|---|
| R. P. Bolton | New York | 54 |
| James Mackay | Chicago, Ill. | 32 |

SECRETARY.

| | | |
|---|---|---|
| W. M. Mackay | New York | 81 |
| J. A. Connolly | New York | 6 |

TREASURER.

| | | |
|---|---|---|
| J. A. Goodrich | New York | 77 |
| U. G. Scollay | Brooklyn, N. Y. | 10 |

BOARD OF GOVERNORS.

| | | |
|---|---|---|
| A. E. Kenrick | Brookline, Mass. | 71 |
| R. C. Carpenter | Ithaca, N. Y. | 73 |
| W. R. Maguire | Dublin, Ireland | 27 |
| John Gormly | Philadelphia, Pa. | 71 |
| C. B. J. Snyder | New York | 59 |
| B. F. Stangland | New York | 30 |
| C. R. Bishop | Lockport, N. Y. | 14 |
| Geo. Mehring | Chicago, Ill. | 30 |
| B. H. Carpenter | Wilkes-Barre, Pa. | 25 |
| Thos. Barwick | New York | 25 |

The result of this vote shows that the following gentlemen have been elected to the respective offices:

President—H. D. Crane, Cincinnati, Ohio.

First Vice-President—Wm. Kent, Passaic, N. J.

Second Vice-President—R. P. Bolton, New York.

Secretary—W. M. Mackay, New York.

Treasurer—J. A. Goodrich, New York.

Board of Governors—A. E. Kenrick, Brookline, Mass.; R. C. Carpenter, Ithaca, N. Y.; John Gormly, Philadelphia, Pa.; C. B. J. Snyder, New York.

For the fifth member of Board of Governors Mr. B. F Stangland, of New York, and Mr. Geo. Mehring, of Chicago, Ill., were a tie vote.

Respectfully submitted,

GEO. I. ROCKWOOD,
H. J. BARRON,
WM. H. MCKIEVER.

The President: Gentlemen, you have heard the report of the tellers. I declare elected Mr. H. D. Crane, president; William Kent, vice-president; R. P. Bolton, second vice-president; William M. Mackay, secretary; J. A. Goodrich, treasurer. For the Board of Governors, A. E. Kenrick, R. C. Carpenter, John Gormly, and C. B. J. Snyder, who will be duly installed later in the session as officers for the ensuing year.

Mr. Jellett: Mr. President, what becomes of the tie vote? That we have got to settle. How many of the Board of Governors are residents of New York or near New York? We generally try to have a working majority.

The President: The Board of Governors elected would be Mr. R. C. Carpenter, Ithaca, N. Y.; A. E. Kenrick, of Brookline; John Gormly, of Philadelphia, and C. B. J. Snyder, of New York.

Mr. Jellett: It seems to me for the Society's uses we had better elect the men nearby who can come to meetings. There is a right way of doing it. We are supposed to have a working majority.

The President: Mr. Jellett, I should have to say under Article 7 of our constitution and by-laws it prescribes very clearly what must be done in the election of officers. The Nominating Committee must nominate; then these ballots

must be printed and circulated and the ballots taken. I think that this matter can be taken up under Section 5 of Article 7, whereby the Board of Governors, finding there is a vacancy, have the power to fill the same, as was done in the case of the death of the first vice-president, Mr. McMannis.

Mr. Jellett: The only point I cannot agree with you on there is this—the wording is very distinct, that they have a right to fill vacancies between meetings. That implies that the Society has the power to fill a vacancy at a meeting. The power vested in the meeting itself is superior to the power vested in the Board of Governors. Then it goes on to say that the power to fill the office for the balance of the term—there is no balance of the term. It is a full term. The implication is that the authority rests with the Society at its annual meeting, I should say. That is the way it strikes me.

Mr. Connolly: Has the Chicago man given his consent to run?

The President: He has. The committee has to obtain the consent of all.

The President: How would Mr. Jellett construe Section 1 of Article 7, where it says:

"Section 1. The Nominating Committee, appointed by the Board of Governors, shall consist of five members, whose duty it shall be to select the candidates for the various offices that are to be filled at the next ensuing annual meeting. This committee shall present to the secretary, at least sixty days before the date of the annual meeting, the names of two candidates for each office to be voted for, first securing the consent of the members selected to stand for the election."

Mr. Jellett: That has been done. We have passed all that.

The President: We have passed all that, but we have failed to elect.

Mr. Jellett: We have failed to elect by reason of the tie vote, and it rests with us to solve the conundrum. I think the power of the organization is paramount to any vested power which exists. To bring this matter to a head I would move that we take a vote of the members assembled tonight, on the question. (Seconded.)

The President: Gentlemen, you have heard the motion

which has been made by Mr. Jellett, and which has been seconded. Is there any discussion of that motion?

Mr. Connolly: I bring up the point that it is unconstitutional, Mr. Chairman.

The President: My decision would be that we have no right to proceed that way. I will make that as my decision now. If Mr. Jellett wishes to appeal from my decision to the house, he has that privilege.

Mr. Switzer: Your ruling is that the Board of Governors can fill the vacancy.

The President: Yes, sir. When the new Board organize they will find a vacancy in the Board of Governors, and under our constitution and by-laws I should rule that they have a right to fill that vacancy the same as they did in the case of the death of Mr. McMannis when he was elected first vice-president.

Mr. Switzer: Is there any objection to an expression of this meeting to guide the Board of Governors?

Mr. Barron: I move that this matter be referred to the new Board of Governors for solution.

Mr. Connolly: Mr. Snyder brings up the point that there has been no election, that there has been a tie, and that a vacancy exists. Mr. Jellett drew up these by-laws and constitution, and took a great deal of trouble to do it, and I trust to his judgment now what he would do in such a case. He is the man that is responsible for the by-laws. (Laughter.)

Mr. Andrus: I should think that they made no selection at all. Let it go just exactly as it is with the four that are elected, and after this meeting is adjourned there is a vacancy and they fill it.

The President: That is my feeling in the matter. They would have that privilege.

Mr. Andrus: I move that we allow the four that are elected to be installed, lacking the fifth, as there is no election. (Seconded.)

The President: I hardly think that would be in order. You have already elected four; you cannot prevent those four from being installed. Perhaps a motion to refer the whole matter to the Board of Governors, with power, would meet the requirements.

Mr. Vrooman: I move that we agree with the decision of the Chair in that matter. (Seconded.)

The President: The secretary will please put the motion.

Secretary Mackay: It is moved and seconded that the Chair be sustained in his decision that it be referred to the incoming Board of Governors with power. Are you ready for the question?

Mr. Franklin: I think that this is an unfortunate position that we are in, that the Society cannot, when there has been no election, elect when they are in their annual meeting assembled. What would happen if it was your president and there was a tie? What would happen if there should be two or three ties? It seems to me that our constitution is very defective if this procedure must obtain, which to me is a very novel one.

Secretary Mackay: I would state for Mr. Franklin's information that our original constitution allowed us to elect officers from the members present, which was only a small portion of our membership and took up considerable time at the meetings, and the constitution was changed so that the entire membership could vote on officers by letter-ballot, and this state of affairs was not considered in framing the constitution.

Mr. Vrooman: I will answer that point. If the office was that of president, the same action could be taken as now. If the Chair had decided that there should be an election, we still sustain the Chair and hold another election—simply sustaining the Chair in his ruling that there is no election, there being a tie, and it is covered by the constitution and the by-laws.

Mr. Barron: The importance of anything we do now consists in the fact that such a thing may occur in the case of president and other officers. By acting now we can establish a precedent which will cover the point properly.

The President: I will state the grounds on which I stand. Section 5 of Article VII of the constitution distinctly says "Whenever by resignation or otherwise there shall be a vacancy in any office between the dates of the annual meetings, the Board of Governors shall have the power to fill such office for the balance of the term."

Mr. Sherman: Mr. Chairman, is there a vacancy?

The President: There will not be a vacancy until the officers are installed.

Mr. Joslin: When the new Board of Governors meet there will be a vacancy, and they can elect their fifth member.

The President: That is the way I look at it. I think there is a motion before the house which has been seconded. If you will dispose of that motion first in which Mr. Mackay, I believe, has put the question, then it will be open, perhaps, to suspend that section you speak of.

Mr. Barron: I think we had better dispose of it that way immediately, by sustaining the Chair, and then we can take up anything with reference to it afterward.

Secretary Mackay: Are you ready for the question? All in favor of the motion say Aye; contrary, no.

The motion was carried.

The President: The next business in order is the topics for discussion.

Topic No. 1: "In the manufacture of radiator nipples should steel, wrought iron, or malleable iron be used to insure the greatest durability?" was discussed by Prof. Carpenter, Prof. Kinealy and Messrs. Kent, Jellett and James Mackay.

This was followed by Topic No. 2: "In proportioning boilers for heating purposes should the boiler be proportioned to the building to be heated or to the radiation provided?" It was discussed by Messrs. Kent, Rockwood, Harvey, Sherman, Jellett, Barron, Jas. Mackay, Secretary Mackay and Prof. Carpenter.

On motion, the meeting adjourned at twenty minutes past ten.

## THIRD SESSION.

Wednesday, Jan. 21, 1903.

The meeting was called to order at 2:30 P. M., President A. E. Kenrick in the chair.

The President: Under the vote of yesterday, the first thing to be taken up this afternoon was a discussion of the Uniform Contract. But, on account of the fact that Prof. Carpenter is liable to be called away, I suggest that a motion be made to the effect that the discussion and the reading of the con-

tract be delayed until after the reading of Prof. Carpenter's paper.

A motion to that effect was made, seconded, and carried.

The President: The next order of business will be the reading of a paper by Prof. Carpenter. The subject is "Test of a Hot Air Gravity System of Heating and Ventilation in a School Building."

The paper was read and discussed by Messrs. Lyman, Jellett, Bishop, Blackmore, Snell and B. H. Carpenter.

The President: We return now to the reading of the Proposed Uniform Contracts of the American Society of Heating and Ventilating Engineers, and the discussion thereon. The subject was carried over from yesterday. I think it might be well to read the report of the committee in connection with the paper.

Mr. S. A. Jellett read the report of the committee as printed on page 336 of this volume.

During the reading of the paper comments were made by Mr. Jellett, as follows:

Mr. Jellett: "Completed and ready for actual operation" does not mean that the last coat of bronze shall be on, or anything of that kind. There may be a number of little things that cannot be done for three, or four, or five months. I have known cases where a year has gone by before the last decorations were finished, and we have defined in this contract that the dates of completion shall be the practical operation of the plant, so that quibbles cannot be raised. It has been held in the case of liens that the practical completion of the work is the time from which the lien shall date. I know of cases where a party has filed his lien within a certain number of days from the time he did the last work in the building, where he was doing some bronzing, or some little thing of that kind, but the courts have held that the completion of the building was the completion of the main work. And I think it is a fair assumption that the practical operation of the plant should be the date for the completion claimed in the contract.

If a man has to start his work at a time named in his contract, he must arrange for the delivery of his material in advance of that time, so as to get his work started at the time named. It may be that the building is delayed from the non-

delivery of other material. His boilers and pumps, for in stance, are delivered, but the building is not in condition to receive them. In such cases the architect usually says that he cannot pass any payments. But it is right that, upon delivery, the contractor should be paid according to his contract. Cases have occurred where the building was retarded six or eight months, and where the materials had to be stored at the expense of the contractor. We have inserted a clause to cover this point.

We have made the contract purposely short, but we have put all the other conditions under the head of General Conditions, and they are referred to in the contract which defines the general conditions as forming a part of the contract. We have suggested that across the face of these general conditions shall be printed the clause referred to in the paper about bidders.

We have made a set of general conditions that we think will meet all cases. There may be some conditions which are not necessary in special cases, and if they are stricken out at the time the specifications are sent out then the contractor is not liable to those conditions.

We have brought out the point that the bidder shall be responsible for the complete erection of the plant in a good working condition. I know of a dispute between a contractor and an architect, where the latter made a riser elevation and neglected to put two lines of pipes, one vertical supply and one vertical return, and the contractor maintained that, because he had not shown those things on the vertical sheet, he was not bound by it, yet the plan showed the radiators. It was referred to me, and I decided that the contractor was responsible. He certainly knew that those radiators were to be used. They were shown on every plan of each floor, and the draughtsman's omission of one or two lines on the riser elevation should not release the contractor from responsibility in a matter of that kind.

I personally recall a case, a short time ago, where I was consulting engineer on a court-house, and where the contract was let to a general contractor for heating. The specifications were very definite as to how the flues were to be made. The quality of the tin, the weight of the iron, and the make of the

iron were very clearly defined. The contractor sublet the sheet-iron work to a sub-contractor and never showed him the specifications. Four wagon loads of flues came to the building made of the poorest sort of tin I had ever seen, worth six or eight dollars a box, whereas the specifications called for tin worth sixteen dollars a box. When I rejected the flues the contractor said the flues were of the right size, but he did not know anything about any special material being required. I showed him the specifications, and he said he had never seen them. The man who gave him the contract for the work had said nothing about the quality of the materials to him. We have, therefore, put in a clause here to this effect: "He may, however, sublet portions of the work, but only under contract embodying these specifications." This holds the contractor responsible in cases of that kind.

I know of one case, a very pointed case, where the engineer resigned his position as engineer. The work was partially constructed, say, about two-thirds completed. The owner then designated the man that ran his boilers and engines as the man who should take the place of the engineer under the contract. This man had never acted as consulting engineer at all. Now, clearly, that is unfair, absolutely unfair. That point came up in our discussion, and we put in this clause "Provided that substitute be a man, etc.," so as to draw the line against putting in a personal friend or an employee in a position of that kind.

One of the clauses draws the line between the owner and the contractor in the matter of insurance. When any material or work has been certified to the owner as being completed, it is the owner's business to take care of his own insurance, but the owner can have no knowledge of work that has not been certified to. Therefore the contractor should take care of that; he is responsible until he has made the delivery to the owner.

The laws in the various States differ so much that we have drawn a clause to protect the owner from claims made against material delivered. I know of cases where material has been bought for a certain building, delivered at that building, and loaded on wagons and taken away to other buildings, and the lien was filed on the building where the material was first delivered. I have even known of a case where three times the

amount of material necessary was taken to one building, and then carted to other buildings, and the lien was filed on the first building to which the material was delivered. Now, the owner should be protected against anything of that kind. There is no question in the minds of the Committee on that point.

We have a general clause inserted in case the owner insists that the contractor shall give up his right of lien. It is the business of the contractor to satisfy himself as to how his payments are going to be made, and as to the surety of his payments. It brings the question right home to the contractor. If, in the face of the clause which we have provided, he deliberately takes the work he knows what he is doing. I have talked with a lawyer who has had large experience. He says: "The sooner contractors realize that the lien law is against their interest the better." He said: "The lien law is thrown as a sort of mantle of protection about the building in such a way that contractors have become careless. You will take contracts to put up a particular building without knowing anything much about the concern. The parties tell you that they have a certain amount of money, but you do not know that. You do not verify it. You will get certain payments as you go along, and then you will file your lien for the balance. Now, growing out of this method of doing business, there is a whole lot of you that have been caught, there is no doubt about that, from the number of cases that come into my office, and the sooner you realize that the wiping out of the lien law would be an advantage to you, and put yourselves in the same condition as other lines of business, the better for you. You will demand security for the payment of your account before you start. And you will know that you are as secure as any man can reasonably be. That is to your interest. The lien law as enforced in the different States has brought out a lot of bogus building corporations and speculative builders who take great chances, and the lawyers' hands are full of such cases. The reason is that you fall back on the plea that you can file a lien. In place of filing a lien you had better compromise at fifty per cent. of your account, because when you have paid all your expenses you will find that you had better have settled the thing at the start." I think the attorney is right.

He said: "I know it from seeing the number of cases that have been brought to my attention, and any attorney who makes a specialty of building contracts knows that this is correct. It would be against the interest of the attorneys, because we would lose a large amount of our business if you used reasonable precaution, but it would be a rational thing for the contractors to do. And there are so many little amendments made from time to time that affect the building law, that it is hard for the average man to keep pace with it." The building law varies in every section of the country, and we have made this clause with the idea that if the owner intends to ask the contractor to relieve him from liens, then the contractor is going to ask the question, "When do I get my money? and how do I get it, and what security have I that I will get it?"

I think that the average contractor who does house heating finds more trouble from the temporary use of apparatus than from any single thing in his work. They use the apparatus to dry plaster and a number of other things, and the owner comes along and expects the apparatus to be the same as new. I had one case the other day where the owner made a demand on me because some one had dropped hot ashes on the tile floor and spoiled it.

A Member: Did you pay?

Mr. Jellett: I did not. (Laughter.)

I have had experience of a case in which we had a contract where the work was completed, and the contract provided that payment should be made at a certain time upon the certificate of the architect. The architect refused to issue the certificate, because he knew the owner had not arranged for his loan. The architect was a friend of the owner, and the owner's financial arrangements had failed. And this clause is inserted to protect a man against any such arbitrary decision as that.

These are the general conditions which we have outlined to accompany the contract. They accompany also the specifications. If the work is awarded to one of the bidders they are attached to and form part of the contract which he is asked to sign. He should have that information at the time of bidding. His superintendent should have knowledge of it during the execution of the work, so that he can protect his interest. And your Committee would recommend to the Society to take

up that contract and put it into shape at as early a day as possible.

The President: You have heard the report of the Committee on Uniform Contract and Specifications as read by Mr. Jellett. What will you do with it?

Mr. D. M. Quay: I move the adoption of the report of the Committee on Uniform Contract and Specifications.

Professor Carpenter: I second the motion.

Mr. Charles E. Oldacre: I would like to say something about the question of arbitration, if it is in order. That is one of the points that were brought out. I had occasion, only a few days ago, not over two weeks ago, to inquire of a Philadelphia attorney of fair standing, as to the question of arbitration, and he told me that under the Pennsylvania law it was decided by the courts that the arbitration clause was not worth the paper it was written on. He said: "You might as well keep it out; it has no bearing on the contract or its conditions." I asked him why? He said "that the courts had not recognized arbitrators at all; that if one individual is named as referee, who is experienced in the line of business which is referred to him, then it is binding. And the arbitration can be made binding if the two parties accept it. But it is not encumbent upon either party to accept it, although it is put in as a condition of the contract, or specifically stated in the contract, and the courts of Pennsylvania have decided that it is entirely irrelevant."

Mr. Quay: This question of Uniform Contract and Specification has been before the Society for several years, and while I would like to add something to what is embodied in the general conditions, I am willing to waive them and adopt the committee's report. I think these general conditions cover the points as well as any I have seen. We do not expect them to be perfect, but it would be wise to adopt these, so that bidders can have a uniform contract and uniform specifications to estimate by, and we will all be working then on the same basis.

Mr. William Kent: It seems to me rather hasty action for this Society to adopt this report. I understand that the adoption of that report means that the Society of Heating and Ventilating Engineers adopts that finally as the standard con-

tract they are going to use. We have not had that report in print, or had it criticised by any one. It has just been read this afternoon. I think it would be better that the report should be accepted or received, and ordered printed, and then be laid open for criticism during the next few months, and finally voted on at a summer meeting. I offer that as an amendment.

Amendment seconded.

Mr. H. J. Barron: I am opposed to the amendment of Mr. Kent, because I happen to be one of this Committee, and I know there is a great deal of work to be done in this direction. This is not final, and you have to make progress, and there is a lot of time which has been wasted here this afternoon in considering the subject. At least I think we might have been occupied with more interesting work. But if you do as Mr. Kent proposes it will simply delay the matter. By the time it comes around again all interest in it will have disappeared. If we adopt it now, it will be published, and it will go to the different associations, and all along the line, and will result in bringing out a form of contract that men may use in their business. If we do not do anything we merely put it off. You do not really accomplish much by adopting it, you simply say that you have formed a kind of an agreement that is acceptable to the Heating and Ventilating Engineers, and the Master Steamfitters and the Contracting Builders, and others can put their own construction upon it, and the Committee's form of contract can come back to us to be ratified. We cannot do anything final. We are only a part of the great influence that is at work in this direction. But something should be accomplished at once.

Mr. Jellett: I think the suggestion of Mr. Kent is partly a good one, and partly not. My own judgment of the matter is that we should have this printed, and sent to all our members, and that we should ask that they criticise it within, say, sixty days from date. I do not believe in carrying it over to a summer meeting, because the summer meeting is usually slimly attended, and most of the men who come to the meeting want to have a good time. I think if we send to all our members, and to the related societies, and say that we want the criticism within sixty days, then let the Board of Gov-

ernors take the sum of these criticisms and consult an attorney of reputation, going over the suggestions and modifying them wherever it is possible to improve them, and then finally adopt it and send it out, it would be much better. I don't see why our Board of Governors, with the information thus put in their possession from the Committee and from the individual members throughout the country, and with the advice of a competent attorney, cannot report on the work within the time named.

Mr. Kent: We shall accomplish just as much by the action I propose as by the action just suggested. I propose that that report be immediately printed. It will be circulated in the newspapers, and circulated as a report of the Society of Heating and Ventilating Engineers. Then it can be stated that it will be voted on within sixty days, and that will advance matters as fast as if we adopted it to-day, after overlooking perhaps some important points.

Mr. C. R. Bishop: There is one clause not in there, and that is a clause for the protection of the contractors for the nonfulfilment of a contract within the period stated, owing to causes over which they have no control, such as strikes on the building, and so on. I think a little clause of two or three lines would fill in that omission.

Mr. Jellett: That matter is taken care of in the form contract proposed. It reads: "If, however, the delay of the contractor be caused by any act of neglect of the owner, or other contractors," and so forth.

Later on, under the question of arbitration, it reads: "In cases where the architect and engineer shall certify," and so forth.

He is protected again there.

Mr. Maloney: There is one clause that I wish to refer to. It is the clause referring to partial payments.

Mr. Jellett: "But only upon certificate of the architect or engineer herein named," and so forth.

The title really has passed to the owner of the premises when a delivery is made into his premises. When it is delivered on the premises the title has really passed. There are only two states in the Union where a contractor can take anything from a building that he has once put in. His redress is

a civil suit for damages or for his account. The loom makers got over the difficulty by means of a lease. Assume that the amount is $100,000; then they agree to lease their machinery for a total rental of that amount. The title then rests in the loom company; they have only leased the apparatus, and if the concern fails they have the right to enter and take possession of their own property. That is a move which has been made within the last two or three years in different sections of the country by contractors to protect themselves in such case. But, generally, the law states that the delivery of machinery into a building is a delivery to the owner, and you cannot enter those premises and take it out.

Mr. Maloney: That is the reason I brought up that point, on account of a construction going on under my supervision, in which the company has been unable to complete the contract. Our payments were eighty-five per cent. of the work, and the material was actually in place. And had these people whom I represent paid for all the material actually delivered, the owner could come in and take that out.

Mr. Jellett: You, as contractor, could not go in and take it out.

Mr. Maloney: No, but the owner could, in spite of the fact that we had already paid for it.

Mr. Jellett: These clauses have been gone over with a lawyer of great reputation on law contracts. He said that there were varying conditions in different states.

Mr. Maloney: In our State of Connecticut, had we paid for eighty-five per cent. of the material delivered us, and not in place, we would have to pay for the material, which the owners can take out of the building.

Mr. Jellett: Could he upon your filing a defense of payment?

Mr. Maloney: Yes.

Mr. Quay: That is a case where the architect and engineer have to use judgment. You cannot make specifications that will cover every particular point. I think these specifications cover it as clearly as it could be covered for the different states. After this specification comes back to be passed on, will it be passed on by the Board of Governors?

Mr. Jellett: Yes.

Mr. Quay: Then it becomes the instrument of the Society.

The President: Mr. Kent, is your amendment made to Mr. Quay's original motion?

Mr. Kent: It is a sort of substitute for the whole thing.

Mr. Quay: Cannot we give the Board of Governors the authority to reframe the contract, after the criticisms which have been made upon it, and then could not they send it out as the uniform contract adopted by the Society, without sending it back to the members for a vote? If that could be done I would like to see it done; it would expedite matters.

Mr. Kent: That would strike out the last clause, as to voting on it at the summer meeting.

Mr. Quay: Yes, sir; I accept the amendment on that condition.

Mr. Kent: I would be glad to accept the modification.

The President: The motion as made by Mr. Kent is before you, gentlemen.

The question being called for the motion was then put and by the president declared to be carried.

Mr. Quay: If that can be printed in time to be put into the book of the Society, it might be well to have it done. I make that suggestion to the committee.

The President: I take the liberty at this time to call upon the Committee on the Tenth Annual Meeting, which committee, as I understand, is ready to report at this time.

Mr. Barron: I am one of that committee. The chairman is sick, and the other member that is here in New York has written out the report. I will read it to you. There is nothing final about it; it is merely a report of progress. The report is as follows:

## REPORT OF COMMITTEE TO MAKE SPECIAL ARRANGEMENTS FOR THE TENTH ANNUAL MEETING OF THE SOCIETY IN 1904.

The Chairman of this Committee, Mr. F. K. Chew, was prepared to make a detailed report of this committee's work at the Ninth Annual Meeting, but at the last moment he was taken ill and prevented from being present or preparing the report so that it could be presented to the Society.

The last meeting of this committee was held about ten days

ago, and there were present at that time Mr. Chew, Mr. Barron and Mr. Seward. At this meeting the main features of the report to be prepared by Mr. Chew were decided upon, and he drew up a brief memorandum, intending at his leisure to prepare the complete report. It was not known to Mr. Barron and Mr. Seward that Mr. Chew had been taken ill until yesterday afternoon, and it has therefore been impossible to prepare a report going into the matter as thoroughly as had been intended if Mr. Chew had not been suddenly taken ill.

The idea of the committee seemed to be that we should use the fact of our having reached a tenth anniversary and its proposed celebration at the next annual meeting as a means of advertising the Society to the trade and profession and to bring forward the scope, accomplishments and benefits of our Society. It was thought that this had best be done by soliciting the interest of each member, so that a personal effort could be made by them among their friends and acquaintances to spread the good features of our Society, and the desirability of its membership to all members of the heating and ventilating profession.

We thought that the Society should not by means of a committee do much soliciting for new members, or in any way make itself conspicuous as desiring new members. We thought that the Society was of sufficient benefit to any member of our profession, and that he would be induced to become a member of the Society if its features were properly presented to him.

Outside of this idea of promoting the membership and welfare of the Society by means of the advertising which could be obtained from this tenth anniversary meeting, it was the idea of this committee that a special effort should be made to arrange an unusually attractive programme and one that would appeal particularly to those of the profession who were not members of the Society, as well as to those who were. For instance, it was thought that the members should be approached and asked to prepare a paper describing some particular and special installation of heating and ventilating which they were familiar with, and which would be liable to cause interest among the profession, because of the fact that such installations would not be met with in ordinary practice, and would

be, to a certain extent, special work or the work of specialists. It seemed that a paper describing the heating and ventilating of transport ships would be particularly desirable, and as also would a paper on the ventilation of tunnels. Mr. Chew understood that some of our members had recent experience in connection with these two subjects and would be in a position to give us very interesting papers. These two subjects are mentioned merely as a sample as what would be desirable, and to give an idea to the members of what was particularly wanted in the way of papers relating to actual experiences.

Another question which came up before us was the desirability of having the Society invite to this tenth anniversary meeting prominent men in our profession, and then provide a banquet or some other social entertainment to bring them into close fellowship with all of our members. It was not thought that an invitation of this kind could be issued unless some provision was made by the Finance Committee for the entertainment of our visitors independent of the entertainment which is now annually provided for our out-of-town members by the New York members.

We discussed details of several methods of procedure along the lines mentioned above, but decided that we would not recommend to the Society any definite methods which should be followed, but would submit our report showing the general manner in which it seemed to us that the most benefit could be obtained from this anniversary meeting. Several of the methods proposed were discussed at the last summer meeting in Atlantic City, and Mr. Chew intended to mention these in his report. It was agreed by the committee that some immediate steps should be taken to bring to the notice of our members this tenth anniversary meeting, and to place in their hands something which they could use to explain to their friends. For this purpose it seemed desirable to have the Society prepare a special edition of letter paper for distribution among its members, and for use by them for writing to their friends and acquaintances when discussing or calling attention to the benefits of our Society. It was proposed to make this special letter-head a four-page affair, and have printed on the inside pages a list of the officers and the members of the Society as contained in the latest work. In addition to this, a

brief mention of the work so far accomplished by the Society, its benefits, and the desirability of its membership to the Heating and Ventilating Engineer. The committee thought that the distribution of such a letter-head as this would bring to the notice of our members the fact that we were going to make some special efforts to make the tenth anniversary meeting attractive and beneficial to all who attended. This would get the members interested and at the same time they would have at hand something which they could use on their friends if they desired to call their attention to this meeting, and the desirability of attendance by every heating and ventilating engineer.

We believe that Mr. Chew's report intended to ask the Society, or the Board of Governors, for release after the submission of this report, because it seemed that the best work could be accomplished by the secretary of the Society appealing to each of the members, individually, for papers to be presented at the meeting and for influence among their friends to insure a large attendance.

We also thought that if any invitations were to be issued they had best be sent by the Society through its president or secretary.

The above seems to cover in a rough way the work and suggestions of this committee, but we regret very much that the Society is deprived of the benefit which undoubtedly would have been derived from the complete report which our chairman intended to submit.

The President: You have heard the report, gentlemen. What action will you take upon it?

Mr. Jellett: I move that the report be received as a report of progress. (Seconded and carried.)

The President: The next business in regular order is the reading of a paper by Mr. W. H. Switzer, on "Furnace Heating and Ventilating System in the Public Library at Ilion, New York."

Mr. W. H. Switzer then read a paper, under the title named. It was discussed by Messrs. Connolly, Kent, Oldacre, Lyman, Barron, Snyder, Quay, Baldwin, Prof. Carpenter and Prof. Kinealy.

The President: Is there anything further, gentlemen? If

not, we will pass on to the next paper. It is "Test of a Hot Air Gravity System of Heating and Ventilation in a School Building," by Mr. B. H. Carpenter, a member of the Society.

Mr. Carpenter read the paper. It was discussed by Prof. Kinealy, and Messrs. Connolly, Fisher, Barron, Kent, Quay, Mallony and Oldacre.

The President: Before putting the motion to adjourn I will announce that the officers and the New York members will entertain the visiting members and guests at the Hotel Brunswick, 225 Fifth Avenue, between 26th and 27th Streets, at half-past six o'clock. Members and their guests will meet in the parlor immediately after the close of the afternoon session, and proceed to the dining hall.

On motion the meeting then adjourned to the following day, Thursday, January 22nd, at 10 A. M.

## FOURTH SESSION.

Thursday, Jan. 21, 1903.

The meeting was called to order at 11 o'clock A. M., President A. E. Kenrick in the chair.

The President: The first business for this morning is discussion on the paper read by Mr. B. H. Carpenter yesterday. What is your pleasure, gentlemen, in regard to that paper?

Mr. Quay: Do you wish to turn your suggestion, Mr. Kent, into a motion that a committee of three take the subject under advisement?

Professor Carpenter: I move that the Committee on Standards have that duty.

Motion seconded and carried.

The President: Perhaps if Mr. Carpenter will be willing to say that he will take this subject-matter under advisement, and at our next meeting or some future meeting give us further data which would give information to the members assembled, and would allow us to continue with our other business. If there is nothing further to be said, we will pass on to the regular work of to-day. The next paper is: "Smoke and Gas Flue System in the Ansonia Apartment Hotel, New York," by Mr. R. P. Bolton.

The paper was read by Mr. Bolton and discussed by Prof. Kinealy and Messrs. Barron and Kent.

The President: There being no one wishing to speak further on this subject, we will continue on to topic No. 4: "To what extent should the advanced and successful engineer place his knowledge and experience at the disposal of those who might need it?" There is a question for you to discuss.

The topic was discussed by Messrs. Quay, Barron, Bolton, Kent and Broomell.

The President: If there is nothing further to be said on this topic we will proceed to the consideration of the next topic, No. 5: "Should the Heating Engineer be expected to provide reserve power in the heating boiler he provides after proper allowance is made for radiation and piping in accordance with manufacturer's ratings, to insure the owner an efficient and economical apparatus?" Has Mr. Kent anything to say on this last subject?

The topic was discussed by Messrs. Kent, Lyman, Thompson, Quay and Barron.

At 12:45 P. M. the Society took a recess until 2 o'clock P. M.

## AFTERNOON SESSION.

The meeting was called to order at 2:30 P. M., President Kenrick in the chair.

The President: At the close of the meeting we had under discussion Topic No. 5. I will now call for the reading of a paper on the subject of "Heating Boiler Development," by Hugh J Barron. Also, we have a paper which has been presented to the Society to be read by Mr. Blackmore. As all three of these subjects are in the same line, I think they can be discussed together as a whole. With your permission I will call first for the reading of the paper by Mr. Barron.

Mr. Hugh J. Barron then read a paper on "Heating and Boiler Development."

The President: The subject of Mr. Blackmore's paper is: "The Capacity of Cast Iron Sectional Steam Boilers."

Mr. J. J. Blackmore then read the paper upon the subject announced by the Chair.

The papers of Mr. Barron and Mr. Blackmore were discussed by Messrs. Blackmore, Thompson, Kent, Wolfe, Quay, Sherman and Connolly.

Mr. Barron: I move that the matter of the rating of boilers be the first question discussed in the next annual meeting. (Seconded.)

Mr. Wolfe: I move to amend so that it be the semi-annual meeting.

The amendment was accepted and the motion carried.

The President: We will now listen to the paper on "Cooling an Auditorium by the Use of Ice," by Mr. John J. Harris. In the absence of Mr. Harris I will call upon the secretary to read the paper.

The secretary then read the paper. It was discussed by Messrs. Kent and Barron.

The President: I believe this closes our list of papers to be read. The next regular order of business is the installation of officers. I will appoint Mr. S. A. Jellett and Mr. W. F. Wolfe a committee of two to present Mr. H. D. Crane, of Cincinnati, Ohio, who has been elected your president for the ensuing year.

The committee of two thereupon escorted Mr. H. D. Crane to the chair.

Mr. Wolfe: We have the honor of presenting to you our new president, Mr. H. D. Crane.

President Kenrick: You have been elected as president of this Association. Do you accept the office?

Mr. H. D. Crane: I do.

President Kenrick: Your duties are many and varied, your responsibilities are great; conduct your office so that at its termination it will be said of you "Well done, good and faithful servant." With these remarks I will ask you to take a seat to my right.

The committee of two thereupon escorted to the platform Mr. William Kent, the newly elected vice-president, and Mr. W. M. Mackay, secretary.

President Kenrick: Gentlemen, I will duly notify you that your president, vice-president, and secretary elect have been duly installed into office, and that at this time I deputise the new president to install the incoming Board of Governors. And now, as I retire, I have the honor of presenting to you your president for the ensuing year, Mr. H. D. Crane, of Cincinnati, Ohio.

President H. D. Crane: There are some business matters in connection with our Association that will interest us much more than anything else I might say. The Society is now, probably, in a better condition as to its financial affairs than it has ever been before. For the benefit of those who have not heard the reports, I will say that, after we have made our publications and collected the dues next month for the ensuing year, we will have in the neighborhood of two thousand dollars. This means, of course, that the Board of Governors will have something as a capital to expend for the extension of our knowledge. I can assure you, that whatever we do expend will be on the lines of providing something in the way of knowledge for the money that we expend; at the same time we propose to husband that fund until we can make it something worth our while. There are other subjects that I would like to discuss in connection with the affairs of the Society as I have noticed them in the course of our proceedings. There is one subject that has especially appealed to me, because I began as an engineer in the furnace business, and the furnace trade is in about the same condition that it was about twenty-five years ago when I left it to go into the steam business, in which more facts are known in regard to the practice. I would suggest to that branch of the heating business that they form a society among themselves and get at some of the facts that they seem to be deficient in. I would also suggest that some of the members get at our Committee on Tests, and see if they cannot help them push matters along, so that by the next meeting, or at least one year from now, they may be able to put that branch of the profession on a better plane and furnish us with a little more knowledge on the subject than we have to-day. I wish to thank you all, gentlemen, for placing me in this position, and I assure you that I will do all I can to serve you creditably and to leave the conditions as we find them to-day, or even a little better. (Applause.)

The Board of Governors that you have elected are A. E. Kenrick, R. C. Carpenter, John Gormly and C. B. J. Snyder. The same committee, before appointed, will be kind enough to conduct these gentlemen to the rostrum that they may be duly inaugurated.

The same committee thereupon escorted the newly elected Board of Governors to the chair.

Mr. Wolfe: We have the honor of presenting two of the members of the newly elected Board of Governors, C. B. J. Snyder and A. E. Kenrick.

The President: These are the gentlemen you have elected as governors, and while there is no set form of installation, I will state to you, gentlemen, that you are expected to do your duty.

The President: We will now proceed with the sixth topic of discussion: "Are there any advantages in the use of vacuum systems of steam heating for residences?"

The topic was discussed by Messrs. Joslin, Paul and Barron.

The President: If there is nothing further to be said on the subject we will take up Topic No. 7: "For plants where the steam pressure does not exceed 100 pounds, which is to be preferred, a water tube or a fire tube boiler?"

The topic was discussed by Prof. Kinealy and Messrs. Kent and Barron.

The President: We will now go on to No. 8: "What is the largest pipe that should be used with screwed joints only and without flanges?"

The topic was discussed by Messrs. Barron, Maloney, Quay, Read and Prof. Kinealy.

The President: If there is no further discussion on this subject we will proceed to Topic No. 9: "Has the modern construction of air valves provided a satisfactory substitute for the positive air valve?"

There was no discussion of this topic.

The President: The next topic is No. 10: "In heating swimming pools, does the body of water bear a relative proportion to the grate surface in the heating apparatus as it does in steam heaters and water heaters, and does the method of application change its relation?"

The topic was briefly discussed by Mr. Kent.

The President: Topic No. 11: "Has the recent scarcity of coal aided in the perfection of fuel oil-burning devices to make them practical for use under apparatus for heating buildings and the industrial purposes, and are such devices obtainable?"

The topic was discussed by Messrs. Wolfe, Dean, Meyer, Kent, Lyman and Blodgett.

The President: If there is no further discussion we will go now to the last published subject, Topic No. 12: "For soft coal burning, what changes are necessary in a hard coal apparatus, to secure efficient heating, prevent soot production, to render the management simple and avoid excessive wear?"

The topic was discussed by Messrs. Kent and Quay.

The President: A topic for discussion has been handed to the Chair, or rather a proposition to discuss a certain topic; but your Chair thinks that probably we have not the time to do justice to it. I will read the question, and you can dispose of it in some way. The writer says: "I enclose two questions which might bring up an interesting discussion.

1. Does it require a greater amount of heating surface to give the same results in localities where there is a large amount of moisture in the atmosphere?

2. Can the oil be effectively removed from the steam where a pressure of 150 pounds or more is used on the engines; and does chemical affinity or combination take place at those pressures?"

The latter subject is one of importance, and I believe it is one that should be discussed before a pretty full membership of this organization. It is one that certainly comes in connection with almost every engineering problem in relation to steam. What will you do with this question? Shall we discuss it?

Mr. Wolfe: I move that these questions be placed among the topics for discussion at our next meeting. I don't think we have time to do them justice to-night. (Carried.)

Mr. Quay: I don't think there is time to discuss either one of the topics to-night satisfactorily. But I thought it might be well to bring them before the Society and have some of our experts consider them, and they might be able to bring in some information at the next meeting, and they might be able to make some tests during the year, so that by the next meeting they might have some data to impart to the Society.

Professor Kinealy: I want to say just a word in regard to what has been said by Mr. Quay, and it is apropos this question, too. We have not the time to do the subject justice.

Mr. Quay suggests that there ought to be tests made. That is true. Further, there should be tests made on a great many other things, and we have talked of establishing a paper, a monthly, or weekly, or quarterly. I should prefer to see a certain sum of money, whether it be $100, or $200, or $500 appropriated for the use of the Committee on Tests, to pay the expenses of at least one test a year, on any one subject that the Society may prefer to that committee. There have been tests of this and that, and various things mentioned here to-day, and we are continually saying that we wish the Committee on Tests would make tests of this or that thing. And in line with what Mr. Quay said it seems to me that the Society ought to take some steps toward giving funds to the Committee on Tests, and referring to them certain definite questions that they may settle, or partly settle, or at least work on, and expend this money in doing the work.

Mr. Wolfe: I will say, as a matter of information to Professor Kinealy, that I am very much under the impression that several years ago the Society took action on such a subject, and it remains in the hands of the Board of Governors, to the effect that if we have funds to pay for these tests they have the power to expend them. Am I right, Mr. Secretary? Was not the matter brought up several years ago, and have not our Board of Governors a right to expend certain moneys for tests or other matters they may deem for the interest of the Society?

The Secretary: Such a resolution was passed at one of our meetings.

Mr. Quay: I move you, Mr. President, if it meet with the approval of the Board of Governors, that the Committee on Tests be authorized to expend not to exceed $200 in experimenting as to tests. Are you ready for the question? (Seconded.)

The motion was put to a vote and carried.

The President: Are there any other matters that will come up under the head of Topical Discussions? I hear no response. I would like to announce that the Board of Governors will meet directly after the Society adjourns.

On motion the Society then adjourned until the time of the next meeting.

AMERICAN SOCIETY HEATING AND VENTILATING ENGINEERS.

List of members and guests present at the Ninth Annual Meeting, January 20, 21, 22, 1903.

MEMBERS

| | | |
|---|---|---|
| N. P. Andrus | A. C. Edgar | F. M. Mechling |
| H. L. Anness | A. B. Franklin | Jas. Mackay |
| Homer Addams | J. A. Goodrich | C. E. Oldacre |
| Henry C. Adams | Aug. Geiger | G. O'Hanlon |
| J. J. Blackmore | H. B. Gombers | A. G. Paul |
| Thos. Barwick | J. A. Galloup | J. A. Payne |
| H. J. Barron | A. Harvey | C. B. J. Snyder |
| F. P. Blodgett | Richard Hankin | U. G. Scollay |
| G. C. Blackmore | S. A. Jellett | H. A. Smith |
| Chas. R. Bishop | H. A. Joslin | L. B. Sherman |
| J. M. Bruce | A. E. Kenrick | W. H. Switzer |
| R. P. Bolton | J. H. Kinealy | P. H. Seward |
| S. G. Clark | J. G. Klemm, Jr. | B. F. Stangland |
| A. A. Cryer | C. V. Kellogg | C. B. Thompson |
| Robt. Campbell | C. M. Lyman | C. P. Vanderveer |
| B. H. Carpenter | W. M. Mackay | Wm. C. Vrooman |
| R. C. Carpenter | A. S. Mappett | W. S. Washburn |
| J. A. Connolly | D. J. Maloney | Warren Webster |
| Mark Dean | W. H. McKiever | W. F. Wolfe. |

GUESTS

| | | |
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| E. C. Baldwin | J. F. Kernan | M. P. Osbourn |
| J. B. Bernhard | G. G. McDuff | R. W. Ryan |
| F. C. Bradbury | J. G. Marsh | C. W. Richards |
| R. M. Carpenter | W. W. Mason | H. H. Ritter |
| G. W. Clark | H. T. Murphy | Wm. G. Snow |
| Henry Colwell | A. H. Marshall | L. Tapley |
| G. E. Downe | F. G. McCann | Wm. Tummis |
| L. Franklin | H. Newman | S. Wright |
| J. A. Fish | B. F. Roberts | H. E. Wieber |
| F. H. Fairweather | | |

# PAPERS

OF THE

# NINTH ANNUAL MEETING,

New York, January 20—22, 1903.

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CIV.

# TEMPERATURE REGULATION.

J. H. KINEALY.
(Member of the Society.)

As the wealth of the people of a country increases there comes a demand for more comfortable buildings in which to live and work. The living houses must be to the highest degree comfortable as well as beautiful, in order that the occupants, being at ease as far as physical requirements are concerned, may better enjoy the intellectual pleasures and beauties of existence; and the buildings in which work is done must be comfortable in order that the workers may exert their bodily or intellectual strength to the highest and most efficient degree. And chief among the requirements of physical well-being, of comfort, is a proper and uniform temperature of the atmosphere surrounding the body. This means that, in warm weather, when the outside temperature is high, the temperature inside of the building should be reduced to the proper degree and maintained there; and that in cold weather, when the temperature outside is low, the temperature inside should be raised and maintained at a higher point. The proper degree of temperature which should be maintained in a building depends upon the occupation of the individuals in it and also upon their age and health. For strong, healthy people, engaged in vigorous bodily work, the temperature may be even as low as 55 degrees, although 60 degrees is what is usually considered proper in this country. For healthy persons engaged in sedentary occupations and for young persons in school, 70 degrees may be assumed as the proper temperature. For old, or anæmic, or sick persons, the required temperature is higher than for strong, well persons and may ordinarily be assumed to be about 80 degrees. That is to say, the proper temperature to be maintained in buildings varies between 60 degrees

and 80 degrees, depending upon the occupation, age, and degree of health of the occupants. This means that for most places in this country, in order to regulate the temperature of the inside of a building so that it shall be at the proper degree all the year round, summer as well as winter, there must be installed in the building means for cooling the air in summer and for heating it in winter. A perfect system of temperature regulation implies a system of refrigeration for removing any excess of heat during warm weather and a system of heating for supplying any deficit of heat during cold weather, but there are few buildings in which any attempt is made to cool the air during warm weather; and hence when we speak of temperature regulation, we usually mean some system of controlling the heat supplied to a building so as to maintain therein a uniform temperature on only those days of the year when the outside temperature is less than the required temperature inside. It is in this sense which I have used the words in this paper.

A study of the different systems of regulation has led me to divide them into two orders, viz., *hand regulation* and *automatic regulation*. Each of these may be further divided into two sub-orders which I call *group regulation* and *individual regulation*. Under the head of hand regulation I include all systems which require to a greater or less degree the attention and care of the occupants of the rooms to be heated, and under the head of automatic regulation I include all those systems which require no attention or care on the part of the occupants.

It will be noticed that my definition of hand regulation is broad enough to include the mere turning on or off by hand of the radiator of a room, and many of you may object to this as not being properly a method of temperature regulation. Yet this is a method of temperature regulation, although a very crude one, and from it grew the practice of subdividing the radiation put into a room into two or more small radiators rather than to install one large radiator. It is easier and less troublesome to maintain a fairly uniform temperature in a room which has two radiators than in a room which has only one, because in mild weather only one of the two radiators may be used, thus making the fluctuations of temperature less than in the room where one large radiator only is in use. From this

crude system of hand control also grew the system of installing single radiators divided into two or more sections, each of which could be used entirely independently of the others if desired.

Automatic regulation differs from hand regulation in that each of the radiators or heaters, or group of radiators or heaters, is controlled by a thermostat, a watchful device which takes notice of changes of temperature, and is ever alert and ready to turn on or shut off the supply of heat as may be necessary. In this system there is substituted for the negligent, or forgetful, or busy individual, an automatic device which is never negligent, never forgetful, and never too busy to note the changes of temperature and regulate the supply of heat as the conditions demand.

Here it may not be out of place to say that no system of regulation can operate effectively unless there be at hand an ample supply of heat at all times to respond to the various demands, and this supply thoroughly subject to the control of the system of regulation. No system of regulation can enable an inadequate or too small heating system to properly heat a building. The supply of heat must be at hand and it must be thoroughly subject to the control of the system of regulation. No doubt, many of you know of systems of heating with which were installed thermostatic systems of temperature regulation which failed to maintain the required temperature in cold weather simply because the heating systems were inadequate, and yet the thermostatic systems of control were blamed. So, too, you no doubt know of systems of heating in which the temperature of some of the rooms of the heated building was always too high, in spite of the fact that there was a system of thermostatic temperature control. In these latter cases there was an ample supply of heat, but it was not under full and complete control of the temperature regulation system. A proper system of temperature regulation will very materially aid an inadequate heating system to maintain the desired temperature in all of the rooms of a building by properly dividing the supply of heat so as to give more heat to the exposed rooms and not so much to the less exposed rooms, but that is the sole extent to which a system of temperature regulation can increase the heating efficiency of a plant.

Under the sub-order *group regulation*, I include all those systems of temperature regulation in which the temperature of two or more rooms of a building are regulated or controlled from one point. The number of points from which temperatures are controlled may vary from one for the whole building to one for every two rooms. Under the sub-order *individual regulation*, I include only those systems in which the temperature of each room of a building is controlled entirely independently of the other rooms.

A system of purely group regulation never gives entire satisfaction because it is almost impossible to divide the rooms of a building into groups so that each room of a group will require at the same time the same amount of heat as each other room of the group. The result is that only that room in which the temperature controlling device is located can be maintained at a fixed temperature, and every other room of the group will have a temperature which will differ more or less from that fixed temperature. The more exposed rooms will be at a lower temperature and the less exposed, more easily heated rooms will be at a higher temperature. This system is adopted, usually, simply in order to reduce the first cost of installation of the temperature regulation system. Where an attempt is made to control the temperature of all the rooms of a building from one single point, the system of temperature regulation becomes almost as crude as a hand system in which the temperature of each room is controlled by the occupants shutting off or turning on the steam or hot water from the radiators or heaters in the room. In the case of dwelling houses where it is not necessary for the whole house to be at the same temperature, and a slight or even somewhat large variation in the temperature of the rooms makes very little difference, a group system may be adopted with fairly good success, even when the system is operated from one point of control. That is, by a system of dampers the temperature of the furnace for heating the air, water or steam, may be controlled from the room which is most in use, and by maintaining a fixed temperature in this room the other rooms in the house may be kept at a temperature that will give fair satisfaction. The system of dampers may be controlled by hand or by a thermostat located in the room whose temperature it is desired shall be kept at a

fixed point. Fairly good results may be obtained by a judicious combination of the group and individual systems. Those rooms which have a peculiar exposure, and which may be very easy or very difficult to heat, should each have its own regulation, but those rooms which have about the same exposure and are about equally difficult to heat may be grouped together and controlled from one point. A group system of regulation, however, should not be resorted to except where it is impossible to install a system of individual regulation because of the construction of the building or of the lack of money to pay for the individual system, and wherever it is resorted to it will be found necessary to use great care in the grouping of the rooms if anything like the proper temperature regulation is desired, and usually it will be found necessary to subject some of the rooms to individual control.

The means by which the supply of heat is to be controlled, whether this means be operated by hand or automatically by thermostats, depends upon the system of heating adopted and also upon whether the system is a system for ventilation as well as heating or whether it is simply a system of heating entirely separate and distinct from any system of ventilation. When hot air is used for conveying heat from a source of supply to the rooms to be heated whether the system be furnace, indirect steam, or hot water, or what is known as the hot blast system, the simplest regulation is obtained by opening and closing the valves of the inlet registers to suit the varying demands of the rooms. If the registers are opened and closed by hand, we have a crude system of hand control. This hand system may with care be made to give very good results, because the valves of the registers may be fully opened when there is a great demand for heat; they may be partly opened when there is a less demand, or when there is no demand at all they may be entirely closed. An advance over the system of working the registers by hand, consists in operating them by means of some device which is automatically controlled by the thermostats located in the rooms. Where one pipe or flue supplies hot air to a group of rooms, the temperature of this group may be fairly well controlled by means of a damper placed in the pipe or flue and operated by a thermostat in one of the rooms. Where, however, the hot air system is used not only

as a system for heating, but also as a system for ventilation, and where it is necessary that the temperature of the rooms be maintained at a certain desired point without any change in the amount of air supplied for ventilation, the system of opening and closing the registers cannot be adopted, because this varies the amount of air introduced to the rooms and therefore varies the ventilation. In such cases it is absolutely necessary that there be two sources of supply of air to the rooms and a system of dampers must be installed by means of which hot air or cool air may be introduced into the rooms. When the temperature falls below the required temperature, the dampers must be operated so as to introduce hot air and cut off the cool air, and when the temperature rises above the required temperature, the dampers must be operated so as to introduce cool air and cut off the hot air. But in all cases, the dampers must be operated in such a way that at no time will the amount of air introduced for ventilation be reduced below that required. The dampers may be operated by hand and then we have a system of hand control, or they may be operated by thermostats, in which case we have a system of automatic control. Where the dampers are operated by hand in such a system, satisfactory results may be obtained if some one of the occupants of the room devotes a considerable portion of his time to watching the temperature and adjusting the dampers. In the case of schools and other buildings where the occupants are usually too busy to keep track of the temperature, hand control should not be used, as with it there is seldom a uniform temperature maintained, but thermostats should be used. When it is possible to do so, it will be found best to operate the dampers so as to prevent a sudden change from hot air to cool air, but to mix a certain amount of the cool air with the hot air and thus bring the temperature of the air down to the point necessary to maintain the required temperature in the rooms. When there is a sudden change from hot air to cool air or from cool air to hot air, the system is usually spoken of as an "on and off" system, and when there is a gradual change in the temperature of the in-coming air, made to suit the heat requirements of the rooms, the system is usually spoken of as a "graduated system." The graduated system is the most desirable, but the most difficult to get with thermostatic con-

trol, as it is difficult to arrange the dampers so that they will take an intermediate position between open and closed. Another way in which the temperature of rooms heated by air supplied for ventilation is controlled, is by shutting off the steam or hot water from the heaters by which the air is heated before being made to enter the rooms. This system is sometimes adopted when steam is used. In my opinion, however, the results obtained by such a system are not as satisfactory as those obtained by taking the air from two different sources of supply, one being a hot-air chamber and the other being a cool or tempered-air chamber. Where this system is used, it is usual to heat the air slightly or to temper it before it comes in contact with the heater which is to raise its temperature before it is admitted to the rooms. The opening or closing of the valve by which the steam or hot water is turned on to or shut off from the heater which heats the air, may be done by hand or by some automatic means controlled by a thermostat. This system is applicable to group regulation as well as to individual regulation.

Where the heating is done by direct hot water radiators, the temperature of a room may be controlled by alternately stopping and starting the circulation of the water in the radiators of the room, or by some throttling device, changing the velocity of the circulation so that when the temperature becomes too high, it decreases, and when the temperature becomes too low, it increases. One of the great points in favor of hot water heating, urged by its advocates, is that it is easy to regulate the temperature of each room or group of rooms by adjusting either by hand or automatically the circulation of the water when it leaves the heater, so as to supply the various radiators with water at a higher or lower temperature, according to the demands of the building. Circulation in a hot water system begins when the water has been heated a comparatively few number of degrees above the surrounding atmosphere, and it is increased by increasing the temperature of the water. And further, the amount of heat given off by a radiator depends upon the temperature of the water flowing through it, and hence a hot water system of heating admits a fairly thorough system of temperature regulation.

Reviewing what has been said in regard to hot water sys-

tems of heating, it is seen that there are three ways as follows of controlling the temperature of a room heated by direct hot water radiation:

1. By maintaining a high temperature in the supply pipe and alternately connecting and disconnecting the radiators from the heating system by opening or closing the inlet valve.

2. By maintaining a comparatively high temperature in the supply pipe and adjusting the temperature in each radiator by some throttling device which will regulate the flow of water into and from the radiator.

3. By changing the temperature of the water in the supply pipe according to the requirements of the system.

To these might also be added a fourth way, which is to have the radiators so arranged that only such portions of the heating surface of any one of them as may be necessary may be put into use.

The first method, that is maintaining a high temperature in the supply pipe and alternately connecting and disconnecting the radiators from the system by opening and closing the inlet valve, is the method most usually adopted, and it is objectionable because when the radiator is disconnected from the supply pipe by closing the inlet valve, there remains in it a large body of water at a comparatively high temperature which must cool before the room can begin to get cooler. The larger the radiator and the hotter the water, the longer will be the time which must elapse between the closing of the valve and the decrease in the temperature of the room, and during the whole of this time the temperature of the room will have been increasing; so that when this method of control is used and when the radiators are large and the water in them is at a rather high temperature, the fluctuations of the temperature of the room, even though there be an automatic control, are apt to be considerable. This method, however, admits of the perfect individual control of each radiator or of the radiators of each room, although it may be used for group control of a number of rooms, and is adapted to either hand or automatic regulation.

The second method, which consists in maintaining a high temperature in the supply pipe and adjusting the temperature in each radiator by some throttling device which will regulate the flow of water into and from the radiators, is adapted to

either hand or automatic regulation and to either group or individual regulation. It presents on the whole the most favorable features of any method to be used in connection with a hot water direct radiation system of heating. The throttling device, however, in order to make this system of value, must be so arranged that, as the temperature rises, the throttling will increase gradually and change in such a way as to allow to flow into each radiator or group of radiators only the necessary amount of hot water required to maintain the radiator or group at the temperature necessary to heat the room. This method is really a combination of the first and third methods. It enables each radiator to have circulating through it water at a different temperature, and yet the system is able to supply to any radiator water at any temperature up to that maintained in the supply pipe of the system. This method enables one to have in the radiators of an exposed room water at a high temperature, and in the radiators of a less exposed room water at a comparatively low temperature. It preserves also a uniform temperature in each radiator. The objections to this system are that it is somewhat difficult to arrange the throttling device by which the flow of water into the radiators is regulated so that it will automatically adjust the flow and thus maintain the required temperature in each radiator.

The third method is seldom used, except where it is desired to control the whole building from one point. A thermostat is usually located in some one room of the building, and by means of a special arrangement of dampers, the fire in the hot water heater is controlled so as to maintain a certain desired temperature in the supply pipe. This supply pipe feeds all of the radiators, and by supplying to them all water at the same temperature, an attempt is made to control the temperature of the whole building from one point. Of course in conjunction with this method there may be used the method of opening and closing the valve on the inlet of the radiator, so as to alternately connect and disconnect it with the supply pipe.

The fourth method, which consists in putting a greater or less amount of surface of any one radiator in use, has not, I believe, been very much developed. The amount of heating surface that would be in use would have to be controlled by subdividing a radiator into sections and cutting one or more of the

sections out of use as occasion required, or by partly emptying the radiator when a smaller amount of surface is desired, and filling it again as more surface is needed.

Of course any one of the methods of controlling a hot water direct radiation system might be equally well used for controlling the heaters or indirect radiators of an indirect hot water heating system. An indirect hot water heating system is really a hot air system and it would be preferable to use one of the methods of regulation which I have mentioned for hot air heating systems.

A consideration of the different methods of regulating the temperature of rooms heated by direct radiation steam systems, leads to the conclusion that they may be classed under four heads as follows:—

1. Varying the pressure in the supply pipe and correspondingly varying the pressure in the radiators.

2. Maintaining a fixed pressure in the supply pipe and alternately connecting and disconnecting each radiator by opening and closing a valve.

3. Maintaining a fixed pressure in the supply pipe and increasing or decreasing the amount of radiating surface of each radiator according to the demands.

4. Maintaining a fixed pressure in the supply pipe and a lower pressure in the return pipe with an intermediate pressure in each radiator, controlled by some throttling device between the supply pipe and the radiator.

The method of varying the pressure in the supply pipe and thus supplying steam to the radiators at a different pressure, the pressure in the radiators being always the same or very nearly the same as that in the supply pipe, is, of course, a very crude method of regulation and one which would be used only when an attempt is made to control a whole building from one point. The range of pressures in the radiators will, of course, depend upon the maximum pressure carried in the boiler, and also upon whether or not there is some air removal system by which it will be possible to maintain in the supply pipe and radiators a pressure less than atmospheric pressure.

The second method, which consists in maintaining a fixed pressure in the supply pipe and alternately connecting and disconnecting each radiator by opening and closing a valve, is

the method which is almost universally used when thermostatic systems of regulation are installed. It is adapted for group regulation as well as individual, and has been developed more than any other method of control for use with or without thermostats.

The third method, which consists in maintaining a fixed pressure in the supply pipe and increasing or decreasing the amount of radiating surface of each radiator, has not been developed to the extent which it might be. This method has been used to a certain extent where radiators composed of two or more sections are installed; the sections being arranged so that each can be used independently of the others. Another way of varying the surface, which so far as I know has not been developed to any great extent, consists in allowing the radiator to partly fill with water, thus reducing the amount of surface in contact with the steam and thereby reducing the active radiating surface. Still another method which has been suggested and experimented with, consists in filling a part of each radiator with air or preventing the air from flowing out of a part of each radiator, thus rendering the part which is filled with air inactive. The air is supposed to be taken out of or put into the radiator, thus rendering a greater or less extent of it active and useful, according to the needs of the room in which it is located. The flow of air into or from the radiator may be controlled by hand or by some automatic device such as a thermostat, and this thermostat may be placed on the wall of the room in which the radiator is, or it may be placed on some part of the radiator itself. When the thermostat is placed on the wall, the control is exercised in a manner similar to the control exercised by the ordinary thermostat in every day use; but when the thermostat is placed on some part of the radiator it is so arranged that when the radiator gets hot up to the thermostat, the flow of air out of the radiator is stopped, thus limiting the amount of steam which can flow into the radiator and thereby the amount of active surface. Of course, in this method, when it is desired to decrease the surface of a radiator, some means must be used for forcing the air into it and forcing out the steam already there.

The fourth method, which consists in maintaining in the supply pipe a fixed pressure and a lower pressure in the return

pipe, with an intermediate in the radiator, which is controlled by some throttling device between the supply pipe and the radiator, is a method which, in my opinion, offers many advantages. The pressure maintained in the radiator may by suitable devices be made to vary from that maintained in the supply pipe almost to that maintained in the return pipe, and thus the range of pressures will depend upon the difference between the pressures maintained in the supply pipe and the return pipe. The greater this difference is the greater will be the range of temperatures, and hence the range of the heating effect of the radiator. This method is adapted to hand control or automatic control. Where hand control is used, the throttling device may be an ordinary valve on the supply pipe leading to the radiator, but where the radiator is controlled automatically, the throttling device must be controlled by a thermostat. Of course, for this method, it is necessary to have between the radiator and the return pipe some device which will permit the water condensed in the radiator to flow out and yet will not permit so large a quantity of steam to escape as to prevent the maintaining in the radiator of a pressure higher than that maintained in the return pipe. This method has the advantage over the first method mentioned, which consists in varying the pressure in the supply pipe and correspondingly varying the pressure in the radiators, in that the pressure in each radiator may be varied without regard to the other radiators: that is, a different pressure may be maintained in different radiators according to the needs of the rooms in which they are located. A high pressure may be maintained in an exposed room and a much lower pressure in a less exposed room. This method of regulation when used with steam would seem to give to direct radiation steam systems all the advantages claimed for hot-water systems and which come from varying the temperature of the water in the radiator.

As said in connection with the methods of regulating hot-water systems, any of the methods spoken of here for direct radiation steam systems may be used with indirect radiation steam systems.

The questions which naturally present themselves to the mind of any one considering temperature are: first, is there any need for temperature regulation? and second, does the public

recognize this need in such a way as to make a demand for temperature regulation?

I think that every one who has had occasion to spend any length of time in a school building where the rooms were occupied by a large number of children, or in a crowded lecture room, or in an office room of any one of the large office buildings where there is no temperature regulation, will admit that there is a need for suitable and proper temperature regulation and a need that has become almost a "crying need." In schools and lecture rooms where there is not thermostatic regulation, there is always a great deal of dissatisfaction and complaint on the part of the pupils and teachers or audiences and lecturers; and in the office buildings there is, I think, complaint which is growing louder and louder every day. This complaint is on account of the irregular fluctuating temperatures. The complaint is that the heating surface is turned on, and then, every one being busy, the temperature becomes so high as to be uncomfortable; then the radiators are turned off and no further attention is paid to them until the temperature becomes so low as to be uncomfortable. The result is that the occupants of the room are subjected continually to a temperature which fluctuates from one which is uncomfortably hot to one which is uncomfortably chilly. There is need for temperature regulation which will be as little as possible dependent upon the care and attention of the occupants, and which will be independent of negligence or forgetfulness.

In reply to the second question, it seems to me that the public generally has answered in the affirmative by demanding everywhere throughout the country, that schools at least shall be provided with an adequate system of temperature regulation, and by demanding further that this regulation shall be independent of the teachers; that it shall be automatic. The public has not yet gotten to the point where it demands that the rooms of office buildings and other buildings in which men spend a large portion of their lives shall be subject to temperature regulation, but the fact that here and there, temperature regulation, and automatic temperature regulation at that, is installed in various buildings, shows that there is a demand which is slight, which is growing, but which is not so great as to induce owners of buildings to spend the money

necessary to install automatic regulation. I think, however, that if some method of hand regulation other than the crude one of turning on or shutting off the radiator could be made fairly successful, there would be at once a ready market for it, because of the need which now exists for temperature regulation. And the public having once enjoyed the comforts of a fairly successful method of hand regulation would demand more and more that systems of automatic regulation be installed in connection with heating systems.

In this connection it should be remembered that there are plenty of people who want the best of everything and especially do they want everything which will contribute to their ease and comfort, and these people are not only able, but willing to pay for what they want, provided always that the service rendered is satisfactory. These people are now demanding temperature regulation in connection with heating systems.

Temperature regulation which actually regulates prevents the loss of heat by preventing the unnecessary over-heating of the rooms of a building, and by regulating the demands on the heating system in exact accordance with the requirements of the different rooms, and in this way it tends to make the operation of the heating system more efficient and economical. So that a proper system of temperature regulation is conducive not only to the comfort and well-being of the occupants of a building, but also to economy of operation of the heating plant.

## DISCUSSION.

Mr. Rockwood: Mr. President, I should like to ask the author of the paper if he has had any experience with what is called the Tudor system—the thermograde system?

Prof. Kinealy: No, sir, I have not. Of course in looking up the different methods of temperature regulation I have run across the Tudor system, but I did not know until a short time ago that it was called the thermograde system. The system is similar to one of those I described to you and would be included under that system in which you regulate the pressure of the radiator at some point intermediate between the return and the supply.

Mr. Joslin: Mr. President, the paper is so excellently written

and is such a valuable treatise that I hope some of the members will discuss it. I notice that the Professor lays great stress on the throttling device of the hot-water radiators and also on the temperature control—what he terms the "graduated system." He also says that the graduated system is most desirable but the most difficult to get. I will see the Professor afterward. (Laughter.)

Mr. Barwick: Perhaps Professor Kinealy can give us a little light in reference to the different methods of connecting the thermostat to the radiator so that a certain portion of the radiator will be in operation and the other part will be closed and cold. I would like to hear from him.

Professor Kinealy: The method that Mr. Barwick has reference to is that in which a radiator is supposed to empty or be filled with air as the demands for more or less heating surface change. There are patents covering these things. I have made experiments in which I have been able to control a part of a radiator system by controlling the flow into and out of the radiator of air, and a part of the radiator would be hot and the rest cold. You will find systems similar to that described in quite a number of places. Is that what you mean, Mr. Barwick?

Mr. Barwick: I would like to hear from Professor Kinealy the exact method which he employed in that test.

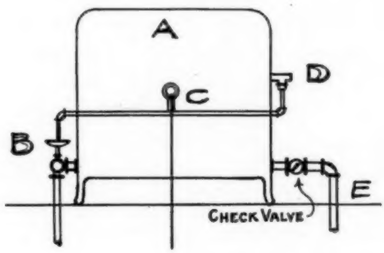
Professor Kinealy: I am perfectly willing to show you the exact method I employed.

Mr. Barwick: That is what we want.

Professor Kinealy (Making a sketch on the blackboard): A represents the radiator; B the thermostatic valve; that is to say a valve controlled by a thermostat such as you find anywhere in the open market. C is the thermostat. Mine was a very crude one. As a matter of fact I used a part of one of the thermostats on the market. D is an air valve. E is a line running to an exhauster. When there was a vacuum in the pipe between C and B, the valve B was opened, and when there was no vacuum the valve was closed.

The thermostat was placed on the radiator at any point. When the thermostat got hot the vacuum in the pipe leading to the valve B and also in that leading to the air valve D was broken, and the valve B closed and the radiator opened

through the air valve to the atmosphere. No more steam could go in; it could not get beyond the thermostat. It took me a long time to get a thermostat that would not let the heat get beyond it; that is, get one that would act promptly. The thermostat could be moved from point to point. Those experiments were made a long time ago.




Mr. Jellett: That is only applicable to the one-pipe system.

Professor Kinealy: Pardon me for omitting to show the check valve F, which I had on the apparatus.

Mr. Jellett: Then you sealed the return to prevent the loss of air through the return?

Professor Kinealy: This, you mean? (referring to G on sketch.)

Mr. Jellett: Yes.

Professor Kinealy: That is where I measured the water from the radiator.

Mr. Jellett: How could you control the loss of air through the return pipe?

Professor Kinealy: There is a check here. (Referring to sketch.)

Mr. Jellett: Would that prevent the loss of air going down the return?

Professor Kinealy: No.

Mr. Jellett: If you control the radiator by a cushion of the air in the radiator and you have a return system of that kind, how do you control it?

Professor Kinealy: As I say, that was an experiment on one radiator. The system was described somewhere and I saw it, and I made the experiment with one radiator. In that case I had no trouble. There was no pressure on the return, you see.

Mr. Jellett: Even if there were no pressure, if there was a vent for your return, you are bound to lose air.

Professor Kinealy: Oh, yes; if it is an open system you will lose air.

Mr. Jellett: You must have some method of sealing that.

Prof. Kinealy: The system with which I was experimenting contemplated the same pressure in the return as in the supply.

Mr. Jellett: That implies a sealed return.

Mr. Joslin: As I understand, the vacuum in the air pipe closed the thermostatic valve?

Professor Kinealy: The vacuum in the air pipe opened the valve. When this thermostat closed I could get a vacuum in the pipe leading from the thermostat to the valve B, and also in the pipe leading to the air valve D.

Mr. Joslin: And when the vacuum is shut off——

Professor Kinealy: When I broke the vacuum so as to throw those two pipes to atmospheric pressure, the valve closes.

Mr. Barwick: The small valve in the thermostat had an air port, did it not?

Professor Kinealy: Oh, yes.

Mr. Barwick: So that the atmospheric pressure forced that valve down into its position?

Professor Kinealy: Yes.

Mr. Barwick: What was the temperature at which the thermostat operated?

Professor Kinealy: I do not know, as I said I had difficulty in getting a thermostat that would operate quickly, that was sufficiently sensitive. I finally got the expansive part of a Power's thermostat and used it to make a thermostat which gave very satisfactory results, but not until I had made two or three thermostats that were unsatisfactory. I made mercury thermostats and metallic thermostats, but they would not work. Of course, there are other systems.

Mr. Barwick: Yes, there are other systems.

Mr. Joslin: I would like to ask the Professor if he took the room temperatures while he was conducting his experiments?

Professor Kinealy: Yes, I took those, but I do not remember what they were. The point in these experiments was this: Could I keep, say, four loops of a radiator hot and five or six loops cold, and could I keep five or six hot and the others cold?

These tests were made, if I remember right, on a radiator having ten sections. I finally succeeded in getting a thermostat that would keep three of them hot and the others cool; but I could not control less than three. I could not keep less than three hot.

Mr. Jellett: Suppose you take a building that had fifty radiators; do you think it possible to obtain control under a system of that kind with the ramification of pipes? Wouldn't there be loss of air enough in the ordinary expansion and contraction to destroy the vacuum? That is rather a pointed question, but it strikes me that you could not hold the air on a large system of piping.

Professor Kinealy: I do not think I quite understand your question, Mr. Jellett.

Mr. Jellett: Well, it is a system of thermostatic control, we will say, that is applied to one radiator. Now, extending it to fifty radiators in a building, with the ordinary system of piping that goes with it, is it possible to maintain those conditions? Would there not be a loss of air due to the expansion and contraction of the pipe system itself enough to destroy the control of such an apparatus?

Professor Kinealy: That would depend on the vacuum pump you used.

Mr. Jellett: Speaking more particularly of the loss through the returns, there is bound to be some slight loss there, and as you multiply the number of units in the system, the loss increases. Is it possible, in your judgment, from the result of that one experiment, to accomplish the same results on an extended system?

Professor Kinealy: I think you could come very close to it.

Mr. Joslin: Professor, a room with ten radiators would require ten thermostats, wouldn't it?

Professor Kinealy: If you wanted to subdivide each radiator, yes.

Mr. Barwick: Professor, have you tested that same apparatus by placing the thermostat on a side wall and admitting air to the radiator without the thermostat being placed on the radiator?

Professor Kinealy: I have not. I saw such a system installed in a building. I have never tested it.

Mr. Connolly: I would like to ask one question. We will assume for an instant that a hospital building was to be heated by direct-indirect hot water—did you ever have any experience in controlling the radiators with a thermostatic valve and also controlling the air inlet at the same time, and if so, what success did you get?

Professor Kinealy: I have never had such experience. I had, however, occasion to study that question very thoroughly, because I was asked to report upon a building in Minneapolis, where they contemplated installing such a system, having, however, steam as the heating medium instead of hot water. I suggested that they try to control the air and let the heater alone. The engineer, I think, contemplated controlling the heater or controlling both air and the flow of the heating medium into the heater.

Mr. Barwick: You spoke of the forcing of air into radiators. Do you mean mechanical forcing or do you mean by natural atmospheric pressure? Of course, we can readily understand that if you place a vacuum on a radiator, by opening that port in the valve, the air forces itself directly into the radiator and takes the place of the vacuum. But you say "by forcing the air."

Professor Kinealy: I mean having air under pressure, the pressure being produced by a pump or fan or some such device connected to the air line or to the radiator in such a way that when it becomes necessary the air will flow into the radiator and push the steam out.

Mr. Barwick: Naturally it would be at pressure.

Professor Kinealy: At pressure greater than the pressure of the steam.

Professor Kinealy: I want to say this: I do not pretend to have experimented with all the methods of temperature control which I have outlined here, but I do mean that such methods have been suggested or described or patents taken out on them, and I have tried to gather all the different methods and to group them and classify them, simply because I am making a study of temperature regulation.

Mr. Barwick: I notice the author states: "Another way of varying the surface, which, so far as I know, has not been developed to any great extent, consists in allowing the radiator to partly fill with water, thus reducing the amount of surface

in contact with the steam and thereby reducing the active radiating surface." I should like to have the Professor state what results he has had with that particular method, if any. (Laughter.)

Professor Kinealy: This is worse than being cross-examined on the stand. I have made no experiments with a system or even with a single radiator where I have used that method. Where that method is used the supply pipe would be connected to the top of the radiator, the return pipe to the bottom, and of course at the other end of the radiator. The return valve would be kept closed and the water condensed in the radiator would be allowed to accumulate and thus reduce the heating surface, and when too much of the surface of the radiator was thus cut off, the radiator being partly filled with water, the valve would open and let it out. As the water flowed out, of course there would be more surface of the radiator in contact with the steam, and therefore there would be more heat given off.

Mr. Harvey: What would the steam do with the water in the mean time?

Mr. Connolly: Is there a patent noiseless attachment on it?

Professor Kinealy: I see no reason why there should be any particular noise.

Mr. Jellett: I can answer that question—there would not be. I tried it.

Mr. Dean: I tried this combination once: The radiators were made for hot water and were put in to use for either steam or hot water. The supply was taken in at the top, and the return out at the bottom. The object of taking the supply in at the top was to prevent the steam from getting under the water. There never was any noise. It was used as a steam plant part of the time. It was used for hot water most of the time. It was changed at will from one to the other, and I don't think there was ever a sound from the system.

Professor Kinealy: I would like to ask Mr. Dean a question. Were you able to keep the water at nearly uniform height in the radiator by throttling it on the return valve?

Mr. Dean: The arrangement was not to regulate the temperature, but to make the apparatus noiseless, and this it did to perfection.

## CV.

# FURNACE HEATING AND VENTILATING SYSTEM IN THE PUBLIC LIBRARY AT ILION, N. Y.

BY W. H. SWITZER.

(Member of the Society.)

There is one method of heating buildings that has received less attention from the graduated engineer than any other, yet it enjoys a popularity that has continued, under the support given by purely practical men alone, in the face of competition that of recent years has not spared expense and has been aided by the employment of qualified engineers to secure the introduction of other methods of heating. It is to secure some attention and assistance from the men who lead as heating engineers that this description of a working hot-air furnace system is presented for your consideration. Unfortunately, the most successful and best representatives of this method of heating have not tabulated their experience so as to afford an opportunity for comparison with the methods that are understood and can be utilized with certainty by the engineers engaged in competing lines. The absence of such data is responsible for many failures in furnace heating by those who have no experience to guide them, and is sufficient reason even at this late date for some effort to be expended in reducing to a comparatively exact science a method of heating that has been in vogue about three-quarters of a century and still retains a distinct field of usefulness.

The plant under consideration has demonstrated its efficiency through ten successive winters, having been installed in the Public Library Building at Ilion, N. Y., in the fall of 1892, satisfactorily maintaining a comfortable temperature throughout, with an average consumption of about 20 tons of coal per winter. An exterior view of the building is given in Fig. 1,

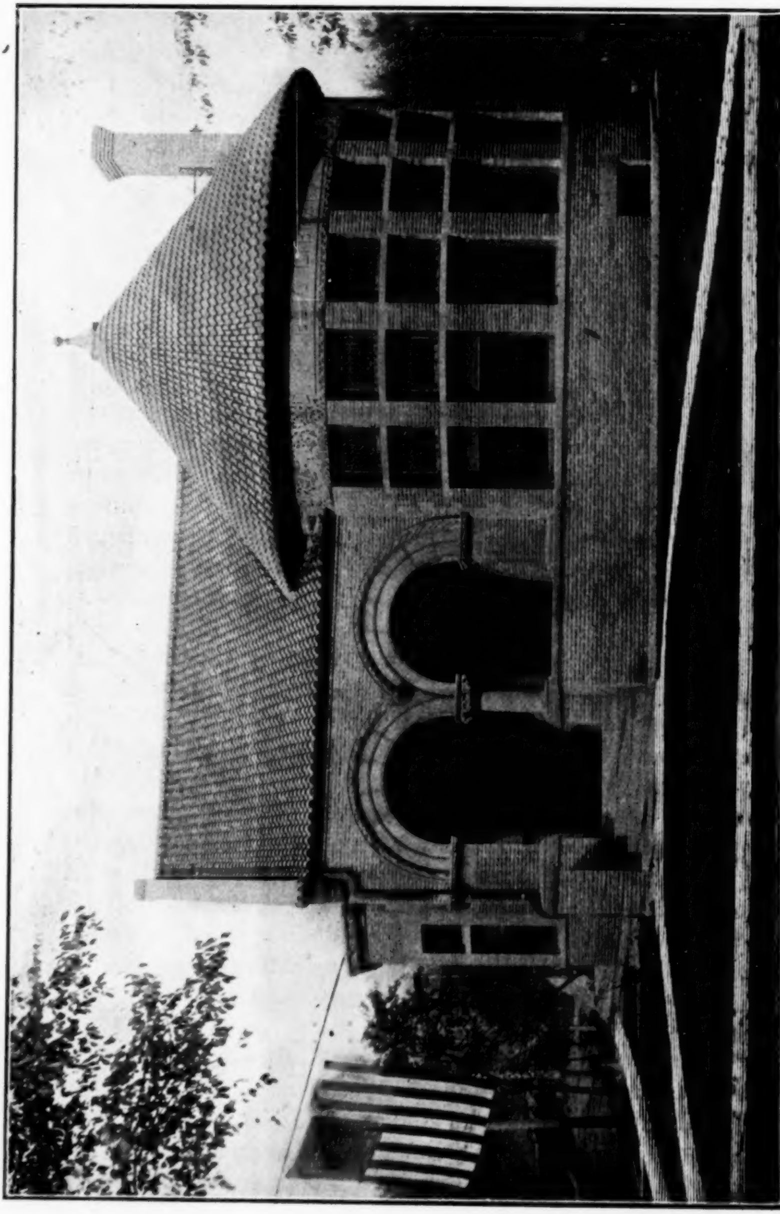
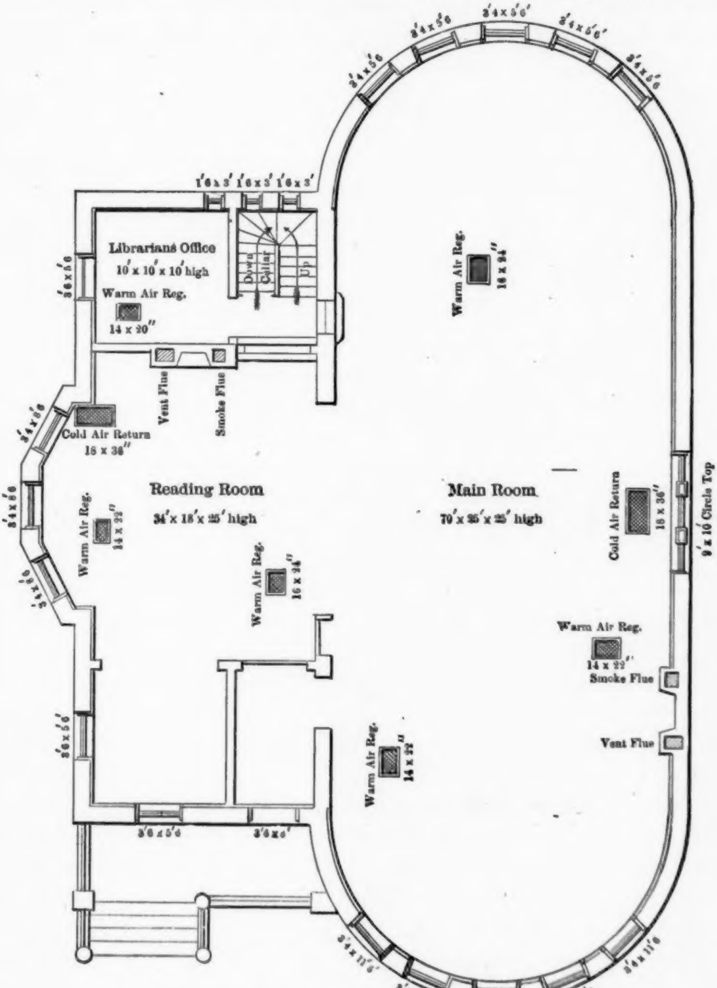


FIG. 1.

and, erected on a corner lot facing east, it is exposed on all sides. It is constructed of brick and stone, the walls being about 16




FIRST FLOOR

FIG. 2.

inches thick, stripped, forming an air space, and then lathed and plastered. Cathedral glass is used in the upper sash of the front and rear windows of the main building with a 9-by-10

foot circular top window above the book cases on the north side. Ordinary windows are used in the other rooms which open into the main library room.

A study of the first-floor plan given in Fig. 2 will show the arrangement of the part of the building that is heated and also the location of the fireplaces, which have a 6-by-32-inch throat tapering to a 12-by-16-inch flue. These fireplaces are never fired and only serve as an outlet flue to aid the ventilation of the building, and under an anemometer test have shown the air movement to be 250 feet per minute. The main room is

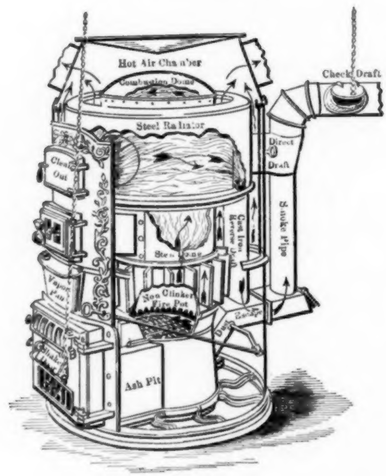



FIG. 3.

25 by 70 feet with a ceiling averaging 25 feet in height. The ceiling is an oval arch finished with lath and plaster on the rafters, which support a tile roof. The main room has a capacity of 43,750 cubic feet, with a wall surface of 3,045 square feet and a glass surface which amounts to 355 square feet. The reading room, vestibule and office have a capacity of 16,350 cubic feet, with a wall surface of 1,976 square feet and 174 square feet of glass surface. This makes a total air space of 60,100 cubic feet, a wall surface of 5,031 square feet and a glass surface of 529 square feet, exerting a cooling effect which must be counteracted by the heating apparatus to the extent of maintaining a temperature of 70 degrees in the building, located at

a point where the mercury at times sinks 18 degrees below zero. The important fact is that the furnaces have fulfilled the requirements under these conditions.

Two furnaces are used of the portable type, having 52-inch galvanized iron casings, a broken view of which is shown in Fig. 3. The casings are double lined with asbestos paper and heavily corrugated bright tin to prevent loss of heat by radiation into the cellar and to prevent the heat from causing the zinc coating to peel from the iron forming the casing. The interior construction provides a deep ashpit supporting a bar grate of the triangular pattern, heavy for durability and of open construction to allow a free entrance of air to support combustion, and having an effective diameter of 22 inches and an area of 378 square inches or 2.62 square feet and a total of 756 square inches, or 5.24 square feet. The ashpit supports a substantial two-part cast iron fire-pot, the lower section being 7 inches deep and having anti-clinker fingers cast on the lower edge, affording a further entrance for air to the combustion chamber with a beneficial effect. The upper section is 11 inches deep, having vertical flanges ½ inch thick and extending 4 inches cast on its outer circumference at intervals of 5 inches, largely increasing the heating surface at an effective point. The fire-pot is 18 inches deep and 26 inches in diameter at the top. Immediately above the fire-pot is a central steel combustion dome, having an opening at the front for supplying fuel. This central dome is made of 10-gauge steel plate and is 28 inches in diameter and 30 inches high. This dome is surrounded by a circular radiator 46 inches in diameter, having inner and outer walls of steel plate 15 inches high, and cast iron heads so connected as to be absolutely gas tight. The products of combustion enter this radiator from the combustion dome at the front and pass each way, making a complete circuit, then passing down a reverse draft pipe to the smoke outlet. This reverse draft pipe also connects with the ashpit to serve as a dust flue when the fire is stoked and to allow any dust collected to drop to the ashpit when opened. The radiator is so located as to allow air to pass between it and the combustion dome, and also up along its outer side, the spaces being properly adjusted to insure heating the air thoroughly without retarding its flow. The fire-pot, combustion dome, and radiator of each

furnace expose 88 square feet of effective air-heating surface, or a total of 176 square feet. By referring to the basement plans given in Fig. 4, the location of the furnaces can be seen

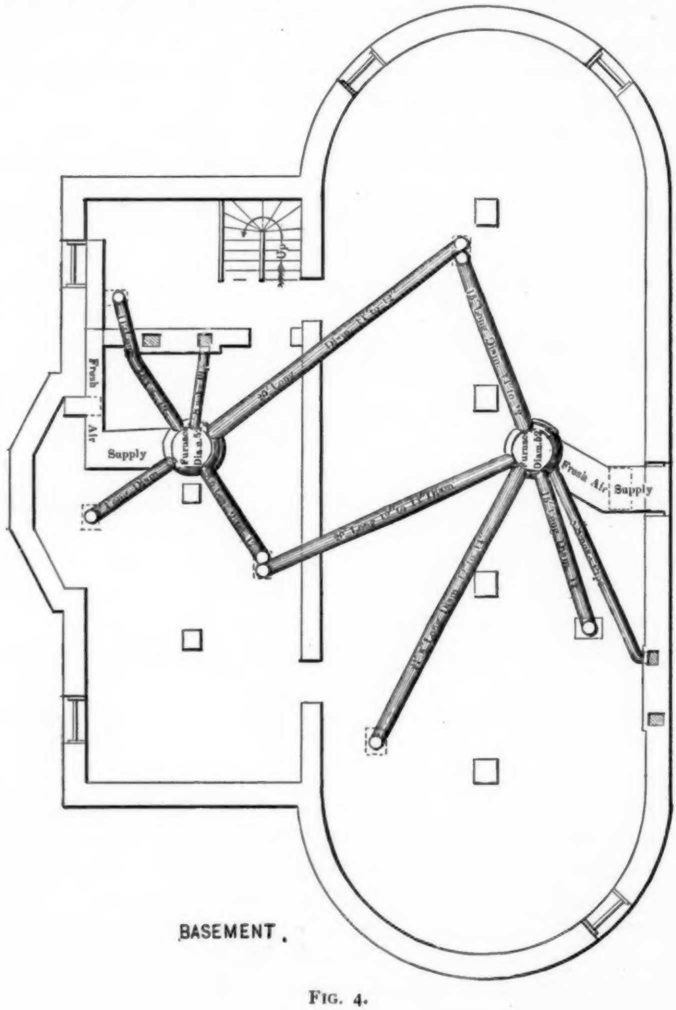



FIG. 4.

and the hot-air pipes and the cold-air supply ducts leading from outside and from the return registers in the floors of the reading room and library.

The method of connecting the air-supply ducts is shown in Fig. 5, from which it will be seen that air in the building can be kept in circulation when few people are in the library or in extremely cold weather, and that the supply, by means of dampers, can be taken conjointly or entirely from out-of-doors to freshen the atmosphere at will as may be necessary. This method of supplying air is widely practised in furnace heating, as its advantages outweigh its disadvantages. It saves fuel, enables quick heating and insures successful heating in ex-

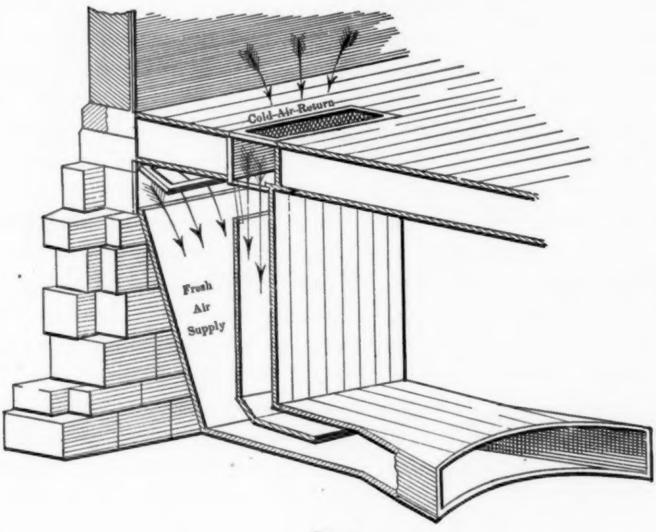



FIG. 5.

tremely cold weather. When all the air is taken from outside there is a certainty of frequent changes of air in the building, as the heated air cannot enter to keep up the temperature without a corresponding volume of air passing out. In this building the fireplaces continually remove a considerable quantity of air to make room for fresh air. The basement plan shows that the north furnace supplies one 12-inch and three 14-inch hot-air pipes, having a combined area of 575 square inches. The south furnace supplies one 10-inch, two 12-inch, and one 14-inch pipes, having a combined area of 458 square inches; the 14-inch pipes in every instance being tapered to 12 inches to

connect with the register boxes; and all the pipes are covered with asbestos paper. The pipes are reduced in capacity by tapering as the air in transit contracts in bulk with loss of temperature, and this method avoids conflicting currents in the pipes and a consequent retarding of the velocity of the flow. This practice is followed by many experienced furnace men with beneficial results. Two of the registers are connected with each furnace to secure a distribution of the heat when but one furnace is used in the milder seasons.

The registers are of the open Persian pattern. The air ducts leading from the outside shown in Fig. 5 are 16 by 40 inches with an area of 640 square inches, and run across above the basement floor, connecting with the bottom of the furnace casing, with an opening 16 by 36 inches, having an area of 576 square inches or ample to fill all of the heating pipes. The return air registers are 18 by 36 inches in size. Each furnace is connected with a smoke flue 12 by 12 inches in size by means of an 8-inch smoke pipe. With the mercury at 18 degrees below zero no difficulty has been experienced in keeping up a temperature from 68 to 74 degrees, and nothing has been expended for repairs up to this time. A recent examination shows the entire apparatus to be in excellent condition, capable of many years of further service. The fact that this furnace system has now been giving satisfactory service for ten successive winters will lend interest to a comparison of various proportions. The building has a capacity of 60,100 cubic feet, a glass surface of 529 square feet, a wall surface of 5,031 square feet. Figuring that 6 square feet of this wall have a cooling effect equal to one square foot of glass shows, by dividing 5,031 by 6, an equivalent glass surface of 838 square feet in the walls, which, added to the 529 square feet of glass surface, gives a total equivalent glass surface of 1,367 square feet. The furnaces have a grate surface of 756 square inches, or 5.24 square feet, and a heating surface of 176 square feet. The cold air supplies have an area of 1,152 square inches, and the hot air pipes of 1,033 square inches. The grate bears a proportion of one square foot to 33.8 square feet of heating surface, to 11,278 cubic feet of space and of one square inch to 1.8 square feet of equivalent glass surface. The heating surface bears a proportion of one square foot to 341 cubic feet of space, and to 7.76 square feet of

equivalent glass surface. The hot-air pipe area bears a proportion of one square inch to 58.1 cubic feet of space, and 1.33 square feet of equivalent glass surface. The coal consumed bears a proportion of one ton to 3,005 cubic feet of space, and to 68.8 square feet of equivalent glass surface per season. There being an equivalent glass surface of 1,367 square feet and at zero the heat units lost by one square foot is practically one heat unit per hour for each degree difference between inside and outside temperatures, and as this is 70, by multiplying by 1,367 it is found that there are 95,690 heat units lost per hour, and for 24 hours, 2,296,560. Figuring that one pound of anthracite coal gives off 14,000 heat units, it will be found by division that 164 pounds of coal will be required per day. By figuring the season that heat will be required at 180 days and multiplying by 164 and dividing by 2,000, it will be found that 14.75 tons of coal will be required. But this would consider no loss by imperfect combustion, no waste in the chimney, by radiation from furnace and piping, and by the vent flues, and it is a matter of record that 20 tons of coal have been the average yearly consumption. The discrepancy between the amount of coal that would be necessary according to the figures and the actual amount used is not greater than the allowance that would naturally have to be made on a common-sense estimate based on experience, giving consideration to the fact that the 14.75 tons figured necessary provide for the consumption of as much coal on fall and spring days as on midwinter days. Figuring that the season contains 180 days, a consumption of 222.2 pounds of coal each day is necessary to consume 20 tons of coal in a season; so divide 222.2 by 24 and then by 5.24; it will be found that 1.76 pounds of coal per square foot of grate surface must be burned per hour on the average, or more in cold and less in mild weather. As uncertain as are the records of an anemometer test, the following records are given, having been taken when the mercury stood at zero: Flow of air at outside cold air supply inlet, 350 feet per minute; at point of connection with furnace, 120 feet per minute; at the two 16-by-24 registers with two 12-inch hot-air pipes to each register, flow of air 380 feet per minute; at the three 14-by-22 registers connected with one 12-inch hot-air pipe to each register, flow of air 300 feet per minute; at 14-by-20 register connected with

one 10-inch hot-air pipe, flow of air 210 feet per minute. Temperature of warm air at register, 140 degrees.

It is probable that further detailed information may be desired in reference to this plant, but it is hoped that sufficient description is given to secure such a discussion of it as will guide others who may prepare papers on this subject in future to make them complete. Doubtless a great benefit would be derived by the furnace trade if the discussion should lead to the explanation of the application to furnace heating of the scientific rules used for other classes of heating apparatus, and if the paper should have such effect it will have more than served its purpose.

The President: You have heard the paper as read by Mr. Switzer. It is before you for discussion.

## DISCUSSION

Mr. John A. Connolly: The remarkable part of the paper to me is that in which he says, on the last page, that he burns 1.76 pounds of coal per square foot of grate surface per hour; and then again, on page 3, where he gives the cubic contents of the building, and the wall surface, and the glass surface. With the ordinary rule for steam heating, calculating the cubic contents, the wall surface and glass surface, with indirect heating he would practically have to use a grate surface of 9 square feet, and with direct steam about 6¾. And we all know that it would burn at least 4 pounds of coal per square foot of grate surface per hour on such jobs. This shows remarkable economy in hot-air heating. And I brought up this point, and would ask if hot-air heating is really more economical than steam or hot-water heating.

Mr. Kent: I have been very much pleased to hear this paper, for the reason that it gives more figures, more facts, concerning an actual installation of a hot-air system than I have seen in a good many years. And it is just the kind of a paper that we ought to have on this subject, and we ought to have a great many of them so that results can be compared. The paper as it stands is a statement of several facts, but the relations between those facts are not very clearly explained. I would

suggest that before the paper is finally printed the author should make out an index, putting in tabular form the various things that we have to consider. When we make boiler tests we report the tests in the form of a table. But if there is any particular figure that we want in this paper we have to look through the whole paper to find it. I have made a rough sketch of a tabular statement. It might take some such form as follows: Cubic contents of building; area of wall surface; area of glass surface; area of roof; equivalent of glass surface; thermal units per hour required to heat building; temperature of outside air; temperature of return air; temperature of mixed air; temperature of exit air; temperature of room; temperature of smoke flue; cubic feet of air passing through furnace, by anemometer test, and also by calculation from temperature (hat is, if we know the temperature of the air that enters the furnace and of the air that comes out, and the thermal units in the coal, we ought to be to calculate approximately the number of cubic feet of air that have been heated); then the velocity of the air in the flue, grate surface, heating surface per square foot of equivalent glass surface in building; heat lost in chimney; estimated loss of heat by radiation in basement, and heat utilized in heating the building. There you have as many things as I have got to make one page of tabular matter. And we could put in another column the same things in another case, or in the same building on another day. And with a number of different results we could, after a while, arrive at general rules. That is what our Society is for—to try and put into practical shape rules for proportioning the heating surface, grate surface, and everything of that kind. There is one thing I should like to ask the author of this paper about. I am surprised to find that he has gotten the warm air flues and radiators so far away from the ends of the building. I would be afraid that there would be a considerable number of cold spots in the room from downward currents of cold air. Has there been any trouble in that respect at all?

Mr. Switzer: Not at all.

Mr. Kent: The man didn't have cold feet?

Mr. Switzer: No, sir. The circulation was continuous throughout the different parts of the building, with thermom-

eters located at various points to ascertain the temperature, and the variation was only from four to six degrees. But I am pleased to have the suggestion made by Mr. Kent, and shall endeavor, if it meets the wishes of the Society, to tabulate the results. I can comprehend the advantage that would be derived from that. The purpose of the paper was to present a system that had been in practice for a term of years, not with the particular view of making a record, but more to bring out discussion, and I shall be pleased to take up the matter and tabulate the results.

Professor Carpenter: I consider the paper of special value, for the reason that we have so very few data on the subject of hot-air heating. Any one who has tried to get hold of data in this line of work has, I think, often found that it is nearly impossible to get hold of anything that can be considered at all accurate. There is really very little excuse for this. The kind described is one of our oldest methods of heating, and we should know more about it than other kinds, but it is the method about which we really have the least information. This is one of the most interesting papers, I think, that we ever had relating to this system of heating. This paper is, of course, not accurate in all respects. It only gives the amount of coal burnt by estimation. It gives an estimate for efficiency of heating of 73 per cent., which is very high for any system. I doubt very much if a test would show an efficiency quite so high as the data in the paper indicate.

Mr. C. E. Oldacre: I would like to ask Mr. Switzer a few questions in regard to the tests made on this building. As I understand, it is a building very convenient to where he lives, and possibly he can give us a little more information on the subject. I have several questions I would like to ask him, and a general answer to all of them would probably cover the matter. The questions are:

1. Was this plant installed according to his plans?

2. How often has he visited the building and at what times of the day?

3. At what time of day did he make the tests?

4. Is the building used and heated continuously?

5. When were the tests made, and what was the outside temperature and wind velocity?

6. What is to be understood by the effective diameter of the fire pots?

7. How does he reconcile the difference between the velocity at the entrance to the heater and at the discharge from the register?

8. In what manner were the anemometer readings taken; at what point in the cross sections of the ducts and flues, and how many tests in each duct and flue; that is, whether the readings were made from an average, or by one reading at one point?

9. Were the anemometer and temperature readings made simultaneously?

10. How and where were the temperature tests made?

11. Were the anemometer tests made with air from the outside or from the return ducts in use?

Mr. Switzer: In answer to the first question I would say that this plant was installed under my personal supervision, and on my own plans, without any restriction. The building was a memorial building, and its donor requested that I install the heating and ventilating system; the plans prepared were subject to the approval of the architect and the superintendent of the building.

The second question is: How often have I visited the building? The first season, in the winter of 1892 and 1893, I visited it perhaps half a dozen times. I visited it quite frequently, not to make any tests, but to see that the system was working according to the plans, and what results were to be had from it.

What time of the day did I make the tests? The particular day that these tests were made was the 12th day of January, 1902; the temperature was eight degrees below zero in the morning. The tests were made about half-past two o'clock. At that time it was a little below zero, one or two degrees. I called it zero in the statement. That was between two and three o'clock in the afternoon, on the 12th of January, 1902.

The building is in continuous use through the whole season, and the furnaces are fired up one at a time in the spring and fall, as the case may require. As the winter season advances both are fired up. The furnaces are run continuously during the cold season.

When were the tests made, and what was the outside tem-

perature and the wind velocity? I have practically answered that.

What is to be understood by effective diameter of the fire-pots? In regard to that feature I mention the construction of the fire-pots. Regarding the diameter of the fire-pots I contend that in the manufacture of a furnace, particularly the diameter of the fire-pots should be regulated in proportion to its grate area and the radiating surface, that is the proportion should be adjusted not by rule of thumb, but accurately and systematically. In the first place the manufacturer should know exactly what work he expects that furnace to perform. He must decide on a certain number of feet of radiating surface, then construct the fire-pot and grate areas containing the fuel to get the combustion. I refer more particularly to the suitable qualities in its effective construction. My experience with a different construction of fire-pot showed a weak spot, and for that reason we constructed this type of fire-pot in sections in order to insure more effective durability.

Mr. Oldacre: On page 3, the third line from the bottom, is where the question arises: "Having an effective diameter of 22 inches." That is the question I would like to have answered. Some manufacturers take the measurements of fire-pots in one direction, and some in another, and one claims one thing as the diameter, and another something else; and another manufacturer makes the fire-pot straight. What do you mean by using the words "effective diameter of 22 inches"—what does that mean?

Mr. Switzer: If the gentleman will look at the preceding line he will find that it refers to grate surface. "The interior construction provides a deep ash-pit supporting a bar grate of the triangular pattern, heavy for durability, and of open construction to allow a free entrance of air to support combustion and having an effective diameter of 22 inches and an area of 378 square inches." It refers entirely to the grate.

Mr. Oldacre: The reason I asked the question is this: Sometimes a fire-pot measures 22 inches at the bottom. As an illustration, we might say that it measures 30 at the top—flares to 30 at the top. Some would claim that they had a diameter of the fire-pot of an average between 22 and 30,

which would be about 26 inches, whereas that is not the diameter of the grate at all.

Mr. Switzer: The only point, as I stated before, where I referred to the effective construction of the fire-pot was on page 5, line 7 or 8: "The upper section is 11 inches deep, having vertical flanges ½ an inch thick and extending 4 inches cast on its outer circumference at intervals of 5 inches, largely increasing the heating surface at an effective point." The effective point is 7 inches above the grate, as I claim.

The next question is: How does Mr. Switzer reconcile the difference between the velocity at the entrance to the heater and at the discharge from the register?

Mr. Kent: Allow me to interrupt. I have been re-calculating those matters which I referred to and I find that there is scarcely any discrepancy in regard to the temperature.

Mr. Switzer: That is of the air supply in the outlets?

Mr. Kent: Yes, sir. These velocities are practically concordant. The difference is not more than six or seven per cent.

Mr. Oldacre: I will say that my question was asked and based on the matter as printed, not as corrected by Mr. Switzer.

Mr. Kent: I wish to add to my previous statement, that it should be corrected where I made the same mistake. Mr. Switzer has corrected these misprints, and then on recalculating it I find that it comes out very nicely.

Mr. Switzer: I wish to cover all the points that have been asked about. The next question is: In what manner were the anemometer readings taken; at what point in the cross section of ducts and flues, and how many tests in each duct and flue? I will merely state that the tests were made at the time from my own personal observation and to my satisfaction, without going into an absolutely scientific and technical test. I had an ordinary anemometer, six inches in diameter, and I held it at the window, with the window open and the temperature at zero. There was no wind, and the pressure was that of the air naturally flowing through the outside opening; and I took the readings at the point of cold-air return. I held it below the floor about six inches, took the readings there, then placed the anemometer at a point where the cold-air duct connects with the furnace proper. And the anemometer was held in

the throat of the register ducts. There were no continuous tests taken at various points to arrive at any particular conclusion as to the outflow and inflow at any particular section.

Were the anemometer and temperature readings made simultaneously? They were not.

How and where were the temperature tests made? I have explained that.

Was the anemometer test made with the air from the outside or from the return ducts in use? They were made both ways. I stated in the paper how the readings were taken.

Mr. B. H. Carpenter: I would ask any gentleman who has had experience what would be the result if, instead of placing in the large room of the library three floor registers, those were all combined into one as near as possible over the top of the furnace, what would be the general result to the heating?

Mr. Switzer: I will say very frankly that I can readily understand what the result would be with that sort of arrangement, inasmuch as with an arrangement of that sort there would be an enormous volume of exceedingly highly heated air forced up at a central point to the ceiling, and it would not nearly distribute itself so freely and equally as by distributing the registers, with a sufficient capacity of supply pipe and an outlet at the register in such proportion as to permit the free circulation of the air throughout the building. I have observed in various sections of the country where different engineers or furnace men have located furnaces in public buildings on that line, where the circulation has not been uniform, it was not satisfactory. At or about the register there was a very high temperature, and the flow of the air was sudden and rapid at times, with a warm fire; with a low fire the cold air would have free circulation into the rooms to be warmed. An arrangement of that nature would not be satisfactory in my judgment at this late day in furnace heating.

The President: There has been a request made that one of our members, Mr. Campbell, give us his ideas on the subject. I believe he is familiar with hot-air heating.

Mr. Robert Campbell: I don't know that I am prepared to enter into the subject this afternoon to any great extent. I must say I was very much pleased with Mr. Switzer's paper. I think it is the first one I have heard read among the mem-

bers on this subject that comes anywhere near what we require in hot-air heating. I want to say that hot-air heating, as I understand it and know it, is one of the best methods we have. I think I can take a dwelling and heat it with hot air before you can get ready to heat it with steam. The reason I say that is—and I think you will agree with me when your attention is drawn to the matter—that the method of hot-air heating is a natural method, and when we proceed on natural lines we are sure to do the work with less trouble and more economy. There are a great many points to be brought out in hot-air heating. It is one of the most difficult subjects we have to deal with, and it is also one of the most abused methods, made more so because of the manufacturers making furnaces without any special regard to their heating powers; their idea is simply selling large numbers of them. Now, referring to a hot-air furnace grate and fire-pot as now made, they will bear a very much larger amount of radiating surface. Considering the inexperience of salesmen representing the manufacturers, and the installation by different workmen, the difficulties are very much increased. The controlling of the cold-air supply is often very much at fault—as a rule a direct connection is made from the outside to the furnace, then if the current is strong it will blow directly through the system with hardly any change in temperature. I find in practice it is necessary to control the current, overcoming force and changes in air currents, supplying what the furnace will require in accordance with the amount of fuel consumed and the work to be done.

Mr. Switzer's idea of the results of a large register directly over the furnace is correct, the largest portion of the heat being lost in rising to the ceiling, returning to the floor as it cools, or otherwise lost, so that a large amount of heated air is wasted. It is better to use several registers instead of one large one.

I believe that Mr. Switzer's paper has started us on the right track; it will surely make the subject of hot-air heating more interesting to us, and good results will follow. There is, however, a place for steam and hot water heating that hot air cannot supply—hot air being the most difficult. Heating and ventilating with hot air and hot water combination is a very successful method, and I consider it an improvement far in

advance of the old systems for heating dwellings. Too much cannot be said of this method, as it overcomes many difficulties met with in other methods without any increase in fuel or care in management.

Mr. Barron: Before this discussion ends I would like to ask some questions. I will ask a question of Mr. Carpenter, which I think will provoke him to talk on the subject. I know he is familiar with the point of view that I take. It is the point of view of comparison, and comparisons are more or less odious. I heated the Cherokee Club building, East Seventy-ninth Street, a building which is almost a duplicate of this, very nearly like it. It has a low-pressure gravity system of heating apparatus, and it burns from 24 to 26 tons of coal in the winter, with a fairly good economical boiler, and all that sort of thing. I don't think it is possible for steam to get any better results. And I have come to the conclusion that the steam man's contention—that steam is so much more economical than the hot-air furnace—is not worth talking about. It is a complicated subject, however. There is no question in my mind but what in the competition between steam, hot water, and hot air, steam and hot water have had the ascendency, and it seems to me that it is more and more so every day. Yet new conditions are arising all the time, and as the last speaker said, there are places for each method. I would like Mr. Carpenter to tell us what his experience has been. He has had experience with hot water and steam, and I would like to get a general expression of opinion as to the relative economy of these methods under varying conditions. Sometime ago I was in St. Paul's Chapel, Broadway and Vesey Street, and that is heated with a furnace in the auditorium, and we have had hot air heating systems in New York City of this character which has been described, but such work is now I believe abandoned.

The President: Would it not be well to defer that question until the next paper is taken up, which will be read by Mr. Carpenter, and is practically on the same line?

Mr. Barron: Very well.

Mr. G. I. Rockwood: We seem to have drifted into a discussion of the merits of the hot-air heater itself. I suppose that the different heating systems in general use are merito-

rious or not for particular situations, for reasons entirely apart from their theoretical characteristics. The question turns on what consequences they bring in their train. The hot-air heater brings the nuisance of furnace gas into the house. Women do not like that. Men can sit through anything and do sit through anything. But wives and children do not like gas in their houses, and plants are killed by it. Now, is there such a thing possible as building a hot-air heater that does not by-pass the products of combustion to the hot-air chamber? I do not see why there should not be, but it is almost certain that there is now no such heater. I put one in my house not long ago that replaced a system forty years old, and I do not use it to-day if I can avoid it. I have a little hot-water apparatus for spring and fall use, and I push that and run open fires, simply because of the objection of my wife to the beastly nuisance of the gas. And this hot-air heater is only two years old! Why can't the hot-air heater be made in sections and put together so that the joints no not open under the temperature of the fire? Can't the sections be made cylindrical, and with flanges, faced and bolted together, instead of the foundry joints that we get, so as to obviate the nuisance of the by-passing of the gases? In addition, there is the objection of the dry hot air. To remedy that a water pan is sometimes used. In my house we think that it moistens the air. Yet my heater is exceedingly economical. I don't know any of my friends who can get along with less coal than I can in proportion to the spaces that we heat, and if there is such a thing as a heater that does not by-pass the gases I should certainly be in favor of using it in my own house.

Mr. C. M. Lyman: I can assure the last gentleman that there are a number of manufacturers that will manufacture heaters warranted gas and dust tight. I have heard men complain in some such strain as this: "My house is filled with gas, and we have to open the windows." I was once called to investigate such a complaint, and as soon as I entered the house, I was asked: "Don't you smell it?" I said that I smelled something. On going into the cellar, I found that the windows were open, and a strong odor of gas. On opening the door of the furnace, partially filled with coal, I requested the owner to step there and smell of the odor at the door of the

furnace, and I said to him: "Does it smell like that?" He said, "No." An examination of his lighting system disclosed a strong leak of illuminating gas from the meter; and that was laid to the heater. And, similar charges are made against the heater in many instances. However, when I went upstairs and talked to the lady of the house, she was very positive in her assertion that it smelled strongest when they put on fresh coal. I wish to say further, in answer to the criticism that manufacturers do not put all the radiating surface that is possible into the heater—I think that is true; but, there is a reason for it. A warm air furnace is one of the most abused apparatus used. They are erected under all sorts of conditions. If a furnace with plenty of radiating surface is connected to the flue which you will find in very many houses, it will not work at all; but, given a proper chimney, and a new building, designed by an architect whom you can reason with, and who will allow you to locate your registers properly, and I do not believe that there is any system of heating which is as efficient or which will give as good results in a moderate sized house as a good, substantial, well-installed and well-paid-for warm air apparatus.

Mr. C. B. J. Snyder: Something happened to me in the same line. We had, in a house occupied by my mother, a hot-air furnace installed some time ago. It was cleaned last winter, after which they constantly complained of gas leakage. I didn't have time to look at it then, but I found later that an intermediate section had been put in upside down, and when that was corrected there was no more trouble.

Professor Carpenter: From my experience with hot-air furnaces I am of opinion that it is only on rare occasions that they actually leak gas. There is actually as much trouble from leaking steam pipes. The gas that usually gets into a house ordinarily comes from the furnace door, that is caused by a bad draft; the gas from the coal gets into the cellar and finds its way into the house. I have at least found that true in two or three cases. Gas from such a source occurs as often with a steam boiler as with a hot-air furnace. I have known of very few cases of gas leakage through the walls of the furnace, and I have had experience with fifteen or twenty different forms, so that I think it is a very rare thing for gas to leak

through the furnace walls. On the other hand, I do not think people are likely to mistake the odor of coal gas for that of illuminating gas.

Mr. Quay: I wish to call attention to the statement that hot air is to be the coming system of heating. There are certain buildings that you cannot heat with hot air, while there are a few others that you can heat with economy by a hot-air furnace. So, such a general statement as hot air being the future kind of heating apparatus for a house is very misleading. You have to take into consideration all the conditions, and select that system which is best adapted to the conditions.

Professor Kinealy: I have listened with a great deal of pleasure to these discussions, and I wish to say that my experience has led me to believe that when there is gas in the house from the furnace it is because the damper of the pipe is closed. I remember once being called in by a rather irascible gentleman, who had blood in his eye. He wanted to sue somebody, or do something desperate, because, as he said, his furnace leaked gas. I got all the old rags and all the things that I could think of that would make bad smells and put them in the furnace, and there was no sign of smell from them as long as the damper in the smoke pipe was open. I take exception to a statement that has been made here in regard to the difference between the air supplied from the hot-air furnace and the air in a room heated with direct steam or hot water radiation to which no ventilation is supplied. When you supply air from a hot-air furnace the air of the heated room will be drier than the air in a room heated by direct radiation, steam, or hot water, where the doors are kept closed, where the windows are provided with weather strips, and where you are simply storing up in the air the moisture from the body and lungs of the occupants. For my part I prefer to breathe the dry air rather than to take into my lungs the moisture coming from the bodies of others. In every well-ventilated room the air is drier when taken from the outside, at a temperature in the neighborhood of zero, or even thirty degrees, and then raised to a temperature of seventy degrees, and kept there in the room. That air is found to be drier unless moisture is supplied to it. Now, in a room heated by direct radiation, steam or hot water, no water, no moisture,

goes through the cast iron or wrought iron radiators in the room, and the moisture that is in the air comes from the occupants of the room.

Mr. H. Addams: The part played by the furnace drum that was put on upside down reminds me of an experience that a certain man had, who made a contract for a tight furnace, but he was not to accept it before being allowed to test it, and he insisted that it had to be erected upside down and filled with water, and if it would stand water he thought it would stand the gas, and I don't think he was altogether unwise. I know of a furnace that has been offered for use and thoroughly constructed as perfectly tight. I know of half a dozen. But it does not seem to matter; whenever you build a new fire in them they empty smoke through the registers, though the cold air is brought underneath concrete floors and in the tightest of cases, and none of it gets into the room from the door being open into the cellar; and still the rooms in houses which I have seen—in one of them my own wife lived—suffer from smoke from a "positively air-tight" furnace, and this is not an uncommon experience. Now, as to the matter of moisture. I don't know whether the vapor pan is a good thing. I have had conversations with two gentlemen in the past two years, both of them had their whole families taken sick with throat trouble on account of the moisture, as they called it, from the furnace, that is, the vapor from the vapor pan. After filling that vapor pan constantly with water and using it for years, and paying expensive doctors' bills, they concluded to abandon it. I have in mind two particular cases. After that they had no use for the doctor on account of throat trouble and on account of colds.

Mr. Rockwood: I have no doubt there are plenty of manufacturers of hot-air heaters who are willing to guarantee that their heaters are gas tight. But I don't think that is convincing. I know of no heater anywhere that is gas tight that I ever saw. My own heater never was from the day it started, and it has not been any day since. Members of my family in other houses have heaters, and there are none of them tight. They have ashes deposited on the mantel pieces and the pianos, due to the flow of air first having been in the fire-pot and then going to the casing. And it is curious what a deep-

rooted conviction there is on the part of architects that these furnaces are not gas tight. In no first-class job can you get first-class architects to recommend such a heater. What he wants to-day is an indirect hot-water heater: First, because he gets rid in that way of all gas in the house, notwithstanding that he has ventilation; secondly, he gets rid of all noises of whistling air-valves, leaky steam ducts and pipes, and so on. I have no question but what a hot-air heater can be made that is tight; but a putty-jointed hot-air heater cannot be made tight. Subject iron alternately to temperatures of 1,500 degrees and 60 degrees, and how many days or minutes is it going to be before your putty-joints have gone? It strikes me that the only way in the world a joint can be made is to make it the same way as you would a steam joint, with flanges and bolts. I don't know whether that has been tried.

Mr. Switzer: It is really amusing to hear some of the remarks made by members in regard to the construction of heating apparatus, when you consider that there are members of this Society who have spent their lives in foundry practice, and who know just as surely and absolutely what can be accomplished with metal, iron, or steel, in regard to the construction of heating apparatus, to make it absolutely air tight, free from dust, gas, or smoke in the hot-air chamber, as they know how to write their own name. They know what can be done, and the paper read this afternoon is of itself sufficient evidence of what has been accomplished in furnace construction. The paper states that the apparatus has been successful, that it has been used for ten winters, with not a single complaint from the librarian in charge and the occupants of the building, and that the furnaces there run continually through the entire winter season. The librarian and assistants are ladies, who usually are susceptible to changes in the atmosphere, if there are any, and very sensitive to the effect of gas and smoke. I can recall in my own experience the fact that there are perhaps fewer complaints from hot-air furnaces, compared with the many thousands of them in use in the United States, than there are in proportion from any other systems of heating; and when my friend speaks of indirect hot water being the favorite system with architects in New England, I want to say that, according to my observation in New England,

some of the most insignificant furnace work in the United States is being executed in New England, and I am not surprised that the results are as stated.

Mr. Rockwood: I did not make any such statement. I was speaking of the very best architects in New England. I don't say that there is not a lot of jerry work done in New England just as in other places.

Mr. Switzer: Referring to the question of indirect hot-water heating, it was my privilege, a few years ago, to be in the city of Philadelphia visiting a friend in the heating trade, who was called up on the telephone by a lady occupying an elegant residence. This residence was designed by a New York City architect. The system of heating was installed by a New York heating engineer. The expense of the residence completed was about $200,000. The heating system had been in use two years. There was a very decided change in the temperature. Automatic regulators for the water supply to the indirect radiators were provided. The temperature was six degrees below zero in Philadelphia, pretty cold for that section; the result was the return pipes frozen, the circulation was stopped, and the master fitter was called in to ascertain the trouble. Upon investigation it was found that there were thirty-two indirect sections in that system that were cracked, and not a section of this radiation was available in Philadelphia. The result was telegraphing and expressing to Philadelphia thirty-two indirect sections to repair the system. The expense incurred to put that system in proper condition would outweigh many obstacles and difficulties that might be charged against the furnace system. Referring to the question of gas coming into houses, I will state, from my experience and observation, that it is a fact that many of our manufacturers do not pay special attention to the construction of their apparatus sufficient to overcome the difficulty of connecting up the joints, largely by reason, I must confess, of excessive competition and to get the price down. The apparatus referred to in the paper read this afternoon were not made that way. They were not installed with a view of being the lowest in price, because there was no competition. The apparatus was selected for its construction, for durability, and for capacity. There is no reason why furnaces could not be constructed that

would not permit gas, smoke, or dust, to permeate the hot-air chamber. The ignorance of the operator, and very often of the consumers and their servants, is more to blame than the apparatus itself in many instances. And with the large number of furnaces in use it is not surprising that there are occasional complaints from neglect along that line. Referring to the question of temperature and the volume of air circulated into the building, I will say that experience has shown that the reason of economy in fuel has been the large volume of moderately heated air circulated into this library instead of a small volume of air heated to an exceedingly high temperature, which, of course, would bring about the objectionable feature which has been referred to by some of the members regarding the quality of the atmosphere, its dryness, etc. In regard to the question why the registers were not placed near the outside walls, to obviate cold feet, I will state that it is a fact that warm air cannot be circulated through hot-air pipes above a certain distance in proportion to the capacity of the apparatus and the square feet of radiating surface, and while some manufacturers claim that some forms of apparatus will carry warm air a long distance, say forty or sixty feet, with splendid results, yet from my experience, taking into consideration the fact that hot air, with the capacity of this apparatus, cannot be conducted beyond a certain point with effective results in getting the requisite volume of air into the building, I will state, however, that the pipes were not run to the outside walls because the uniform circulation desired was gained by the location of the registers as shown in the diagram. I was in hopes that this discussion would have prompted the consideration of a fact that has not been mentioned, in regard to the fan system in connection with hot-air furnace work. It is a fact that many of the engineers in different sections of the country, particularly furnace men, are introducing fan systems in large residences, and in some public buildings, for circulating the hot air more freely.

Mr. John A Connolly: Mr. Carpenter is to read a paper on Hot Air Heating, so that question will come up.

Mr. Switzer: I am glad to know that. I will only state in closing that I am delighted with the discussion that has been engendered by this paper, and trust and hope that it may

lead up to further papers from various talented members of the Society that have had experience in warm air heating, which will bring it more before the heating trades in that line of business throughout the United States that are watching the action of this Society. And it is the province, in my judgment, of the American Society of Heating and Ventilating Engineers to elevate the standard to higher levels and assist those that have not had the benefit of technical training and experience in hot-air furnace heating.

Mr. Baldwin: Mr. Chairman, I would like to take advantage of your invitation yesterday and ask a question, if permitted, although I am not a member. In our schoolhouses in Boston, we have a large number that are heated with hot air, hot air furnaces. We have got one-room buildings and we have got sixteen-room buildings. A sixteen-room building in Boston means there more than a sixteen-room building in this town. It means very much larger corridors, larger assembly hall, larger buildings than those by several times, and those buildings are heated with hot-air furnaces. Now, the question I wanted to ask was this: What is the experience of the engineers as to the advisability of using water pans in the furnaces. There seems to be a large division of opinion in our town among masters and teachers as to the practicability.

I would like to know from the writer of the paper or some one else what his opinion is.

Mr. Switzer: I will say in regard to that, my experience and observation is that in some sections of the United States water pans are desirable and in others they are not. On the Atlantic seaboard I would not advocate water pans as being any advantage. In the mountain regions of Colorado, for instance, where there is dry atmosphere, water pans are desirable and quite necessary. In my judgment, on the Atlantic seaboard or on the Pacific coast water pans are of no advantage.

Mr. Sherman: I would like to ask Mr. Switzer with relation to the location of those registers in this main room—I notice that a portion of this room is stated to be a reading room—whether, in his judgment, the location of those heaters as placed in the diagram, provided it was used for reading and persons were sitting close to those windows, whether, in his judgment, they would not feel the effect of some draft?

Mr. Switzer: There has been no experience unpleasant or uncomfortable from occupants on the east side of the large room, the portion set aside for persons consulting books and catalogues, and I have been there evenings when there were a good many persons occupying the building without discomfort. Of course, these windows are closely fitted; they are not double, but there are no evil effects whatever from circulation in the east or west sections or the bay window on the south. I have seen in the winter students sitting in the bay windows at the south and no inconvenience or discomfort and no question of complaint about drafts. I have looked for them myself and failed to discover them. That was a matter for information and for a number of years I visited the system, to ascertain for my own satisfaction, not with a view of ever presenting it for expert consideration.

Mr. Switzer [Added since the meeting.]: Referring to Mr. Kent's request, that a summary be prepared in tabulated form for ready reference, the following data are herewith presented covering the salient points taken from the paper:

SUMMARY OF DATA OF PLANT.

| | |
|---|---|
| Contents of building | 60,100 cubic feet |
| Area of exposed wall surface | 5,031 square feet |
| Area of exposed glass surface | 529 square feet |
| Total equivalent of glass surface on the supposition that 6 sq. ft. of wall surface is equivalent to 1 sq. ft. of glass | 1,367 square feet |
| B. T. U. loss per hour (Calculated from equivalent glass surface) | 95,690 square feet |
| Grate surface | 5.24 square feet |
| Heating surface | 176 square feet |
| Ratio of heating surface to grate surface | 33.8 to 1 |
| Ratio of heating surface to equivalent glass surface | 1 to 7.76 |
| Ratio of heating surface to thousand B. T. U. loss per hour | 1.84 to 1 |

I am unable to give the area of the roof surface or the number of changes per hour as requested by Mr. Kent.

The test made was not sufficiently complete to enable me to

answer all of the questions asked by Mr. Kent. He will find, however, by referring to the next to the last paragraph of the paper that during the test the temperature of the outside air was zero; the temperature of the air leaving the registers was 140 degrees; and the temperature of the rooms was about 70 degrees. The velocity at the cold air supply inlet was, as stated in the paper, 350 feet per minute, and the velocity of the air leaving the registers varied with the register, but the results of the measurements of several of the registers are given in the next to the last paragraph of the paper.

## CVI.

# TEST OF A HOT AIR GRAVITY SYSTEM OF HEATING AND VENTILATION IN A SCHOOL BUILDING.

BY B. H. CARPENTER.

(Member of the Society.)

During our meeting in January, 1898, the question of Hot Air Gravity Heating and Ventilating was discussed; but not to a very great extent. I then gave a short description of a test which I had tried to make of a system of this sort. The test, however, was not by any means complete, as my thermometers were not of high enough degree, and several were broken in the attempt, thus preventing a satisfactory result.

I have now made a two days' test of a recently installed system, which I will endeavor to give you in detail, together with a description and plan of same.

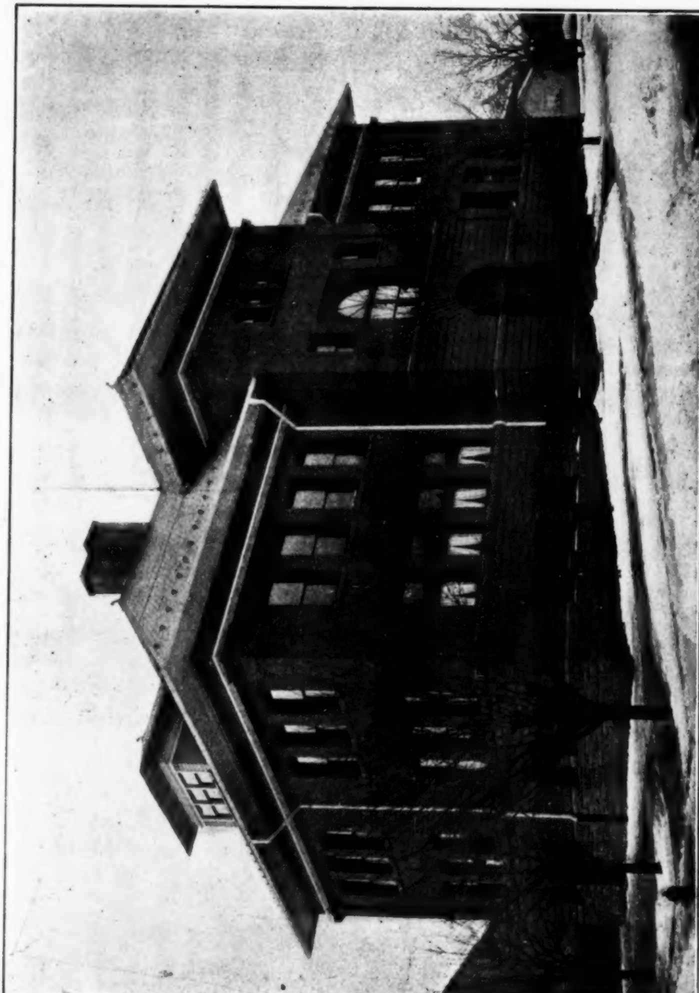
The building is a brick schoolhouse, 1,740 feet above the sea level, and was erected in 1901, the apparatus for heating and ventilating being installed at the time of erection. It contains eight schoolrooms, each 34 feet by 26 feet by 12 feet.

The building stands on the northern side of a hill, facing directly west, therefore having free exposure north, west, and east.

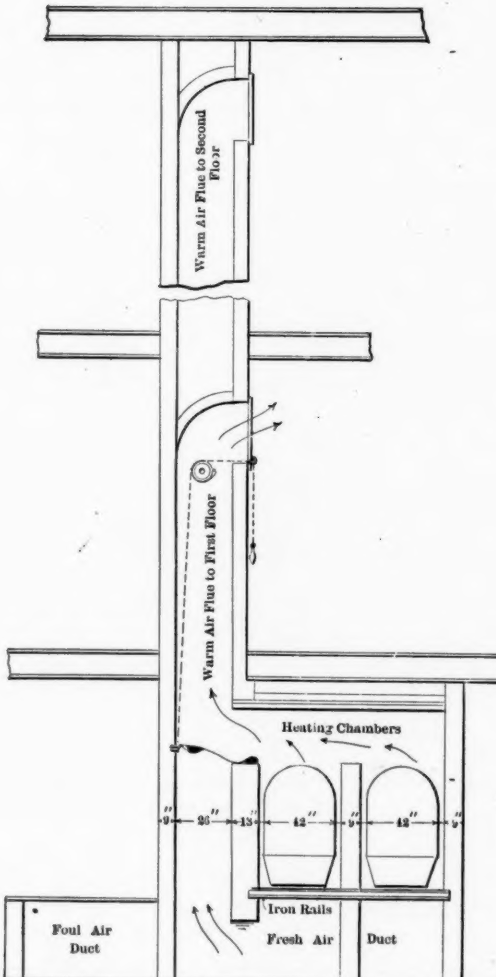
The fresh and foul-air ducts were built of brick, and were laid in with the foundations. The fresh-air ducts enter from all four sides of the building, the north duct being of 23¼ square feet area; the east duct, 34 square feet area; the south duct, 24½ square feet area, and the west duct, 34 square feet area.

The foul-air ducts are of 16½ square feet area each.

The fresh-air ducts, running from all four sides of the building, meet at the centre. The inlets from the air are so arranged that all ducts may be shut off, except at those sides from which the wind is blowing. However, on a murky day the ducts from all four sides may be open.



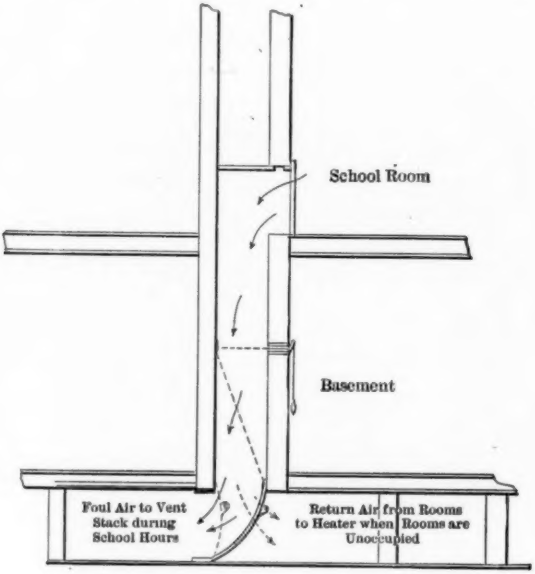
Cross Section through Heaters
Warm Air Flues Foul Air Duct



The warm-air flues to the rooms are of brick, those to the first floor being of 5 square feet area, and those to the second floor 4 square feet area.

The ventilating flues are of 5 square feet area to both floors.

Each room has a separate and distinct warm-air flue and vent flue, the vent flue connecting with the foul-air duct in the basement, which connects directly with the main ventilating stack. This stack is of 15 square feet area, the draft being




Section through Vent Duct

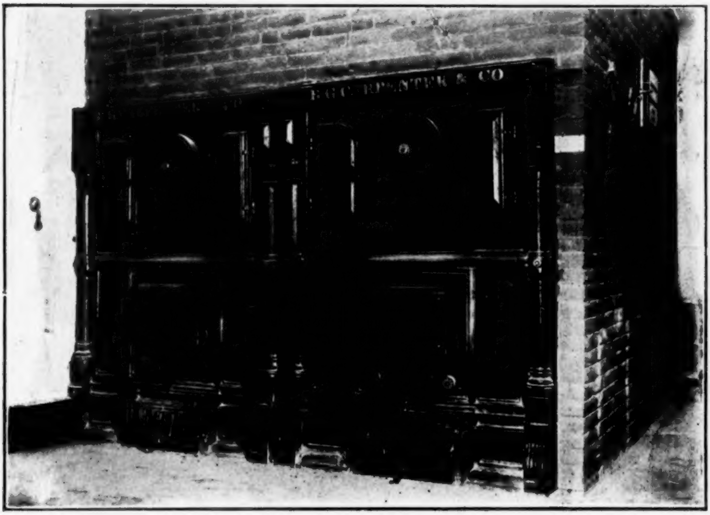
caused by a stack heater in which a fire is kept at all times. This stack is completely independent of all other stacks in the building.

Each room is provided with one warm-air register, placed 8 feet above the floor, and one vent register at the floor. The warm-air openings on the first floor are of 5 square feet area, and on the second floor 4 square feet area. The vent openings are $4\frac{3}{8}$ square feet area for both floors.

The supply of air to each room is controlled by a mixing valve in the warm-air flues, which is operated by the teacher in the room. Each flue also contains a valve at the basement,

by which the air from the building may be returned to the rooms, instead of passing through the foul-air ducts and up the stack. These valves are operated by the janitor. The revolution of the air, however, is not supposed to take place until the building is unoccupied. In this manner the building is kept at a comparatively even temperature during the night, thus saving unnecessary burning of coal, the air at the same time remaining fresh.

A slide damper is placed at the entrance of the warm-air flues



which go from the furnace to the floors above, so that the supply of air may be cut off should it become too great.

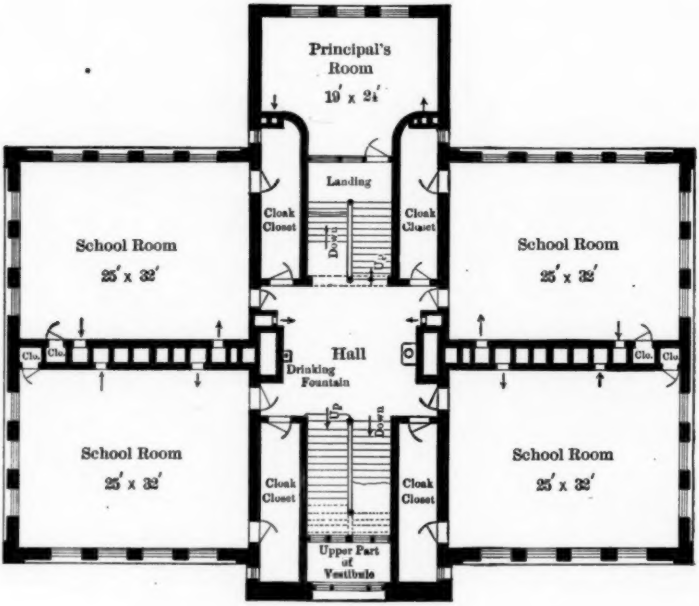
The furnaces are of the tubular type, each having 229 square feet heating surface, estimated to warm from 20,000 to 25,000 cubic feet of space, furnishing enough air to supply 30 cubic feet of air per minute per pupil for 110 or 120 pupils, or two rooms containing 55 or 60 pupils each; and 5¼ square feet grate surface.

They are placed in batteries, one battery at each side of the building at the base of the warm-air flues. The smoke pipe from each furnace is 12 inches in diameter, the two from each battery of furnaces joining and entering the smoke flue at 16 inches diameter.

A separate portable furnace is placed in the basement for the purpose of warming, to a comfortable degree, the halls.

The coal used in firing at the time of the test was a mixture of pea and chestnut, and of a very poor quality, containing more or less slate and coal dirt.

Below is a detailed account of the test made. This included




FIRST FLOOR PLAN

the northwest and southeast rooms on the first floor, and the northeast and southwest rooms on the second floor.

## Test Made on Dec. 16, 1902.

Conditions of weather: Heavy, murky day with rain.

Fresh-air ducts open: All sides of building.

Air entering building: 9,590 cubic feet per minute during morning; 14,560 cubic feet per minute during afternoon.

Dampers for revolving air closed at 8.30 A.M., allowing free passage of fresh air.

## NORTHWEST ROOM, FIRST FLOOR.

| | 8.30 A.M. | 10 A.M. | 12 M. | 2 P.M. | 4 P.M. |
|---|---|---|---|---|---|
| | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* |
| Outside temperature | 34 | 40 | 40 | 38 | 38 |
| Temperature at warm-air flue | 120 | 86 | 102 | 104 | 100 |
| Average temperature of room | 71 | 70 | 70 | 69 | 70 |
| Temperature at vent flue | 67 | 64 | 68 | 66 | 62 |
| Cubic feet air entering per minute | 1,592 | 1,600 | 1,400 | 1,400 | 1,400 |

## SOUTHEAST ROOM, FIRST FLOOR.

| | 8.30 A.M. | 10 A.M. | 12 M. | 2 P.M. | 4 P.M. |
|---|---|---|---|---|---|
| | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* |
| Outside temperature | 34 | 40 | 40 | 38 | 38 |
| Temperature at warm-air flue | 130 | 102 | 102 | 108 | 98 |
| Average temperature of room | 68 | 68 | 68 | 70 | 70 |
| Temperature at vent flue | 59 | 64 | 64 | 66 | 66 |
| Cubic feet air entering per minute | 1,330 | 1,070 | 1,400 | 1,420 | 1,200 |

## NORTHEAST ROOM, SECOND FLOOR.

| | 8.30 A.M. | 10 A.M. | 12 M. | 2 P.M. | 4 P.M. |
|---|---|---|---|---|---|
| | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* |
| Outside temperature | 34 | 40 | 40 | 38 | 38 |
| Temperature at warm-air flue | 90 | 102 | 102 | 100 | 94 |
| Average temperature of room | 74 | 70 | 70 | 70 | 71 |
| Temperature at vent flue | 72 | 66 | 67 | 67 | 70 |
| Cubic feet air entering per minute | 1,818 | 1,687 | 1,725 | 1,685 | 1,390 |

## SOUTHWEST ROOM, SECOND FLOOR.

| | 8.30 A.M. | 10 A.M. | 12 M. | 2 P.M. | 4 P.M. |
|---|---|---|---|---|---|
| | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* |
| Outside temperature | 34 | 40 | 40 | 38 | 38 |
| Temperature at warm-air flue | 110 | 94 | 108 | 110 | 100 |
| Average temperature of room | 74 | 69 | 70 | 78 | 76 |
| Temperature at vent flue | 72 | 66 | 67 | 74 | 70 |
| Cubic feet air entering per minute | 1,367 | 1,312 | 1,500 | 1,650 | 1,687 |

The fires were cleaned at 4 P.M., and the dampers for revolving the air opened. The fresh-air ducts shut off.

At 5 P.M., the fires were banked and drafts shut off for the night.

The amount of coal burned from 8 A.M. to 4 P.M on Dec. 16, was 576 pounds.

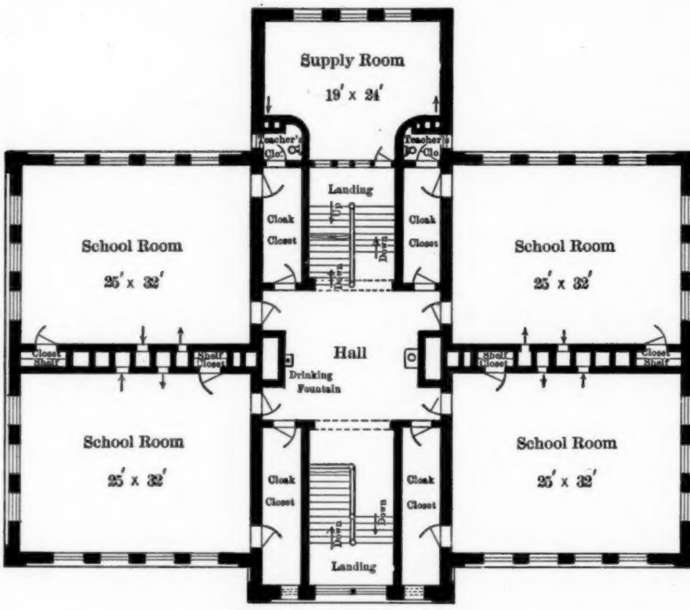
After cleaning the fires at 4 o'clock they were replenished with 180 pounds of coal.

At 5 o'clock they were banked and fixed for night with 252 pounds.

Ashes taken out from 8 A.M. to 4 P.M. on Dec. 16, amounted to 190 pounds.

This is equivalent to about one pound of ashes to three pounds of coal.

After revolving the air for four hours, with all drafts off, the temperatures of the several rooms at 8 P.M. were as follows: N. W. room, first floor, 59 degrees; S. E. room, first floor, 62 degrees; N. E. room, second floor, 61 degrees; S. W. room, second floor, 64 degrees.




SECOND FLOOR PLAN

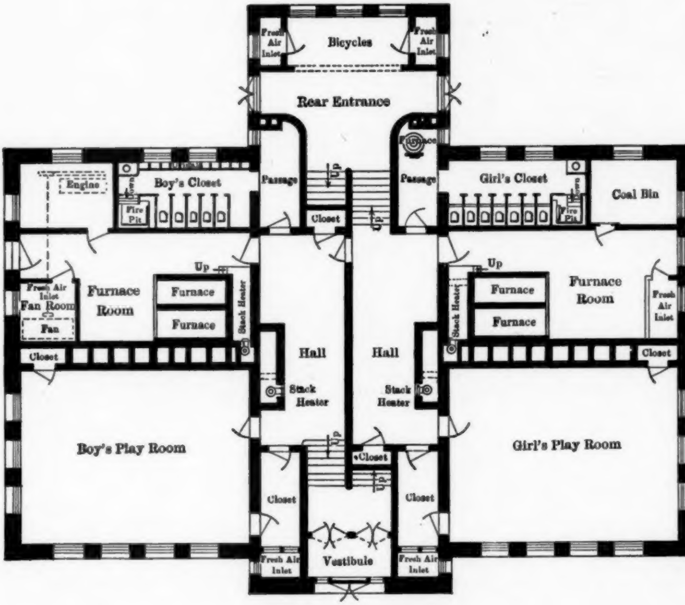
At 7 A.M. on Dec. 17, after the air had revolved for 15 hours the temperatures were as follows: N. W. room, first floor, 54 degrees; S. E. room, first floor, 58 degrees; N. E. room, second floor, 59 degrees; S. W. room, second floor, 59 degrees.

## TEST MADE ON DEC. 17, 1902.

Conditions of weather: Cloudy. Strong N. W. wind.

Fresh air ducts open: All on north side.

Air entering building: 11,425 cubic feet per minute during morning; 11,485 cubic feet per minute during afternoon.




BASEMENT PLAN

Fires were fixed and coal put on at 8 A.M.

At 8.30 A.M. N. W. room first floor registered 70 degrees; S.E. first floor, 70 degrees; N. E. second floor, 69 degrees; S. W. second floor, 76 degrees. Revolving dampers closed at 9 A.M.

NORTHWEST ROOM, FIRST FLOOR.

| | 9.30 A.M. | 11.30 A.M. | 2 P.M. | 3 P.M. |
|---|---|---|---|---|
| | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* |
| Outside temperature | 25 | 28 | 28 | 28 |
| Temperature at warm-air flue | 108 | 96 | 102 | 108 |
| Average temperature of room | 68 | 68 | 72 | 74 |
| Temperature at vent flue | 61 | 66 | 62 | 66 |
| Cubic feet air entering per minute | 1,587 | 1,775 | 1,540 | 1,470 |

SOUTHEAST ROOM, FIRST FLOOR.

| | 9.30 A.M. | 11.30 A.M. | 2 P.M. | 3 P.M. |
|---|---|---|---|---|
| | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* |
| Outside temperature | 25 | 28 | 28 | 28 |
| Temperature at warm-air flue | 124 | 120 | 120 | 115 |
| Average temperature of room | 76 | 72 | 70 | 75 |
| Temperature at vent flue | 70 | 68 | 67 | 68 |
| Cubic feet air entering per minute | 2,100 | 1,960 | 1,866 | 1,585 |

NORTHEAST ROOM, SECOND FLOOR.

| | 9.30 A.M. | 11.30 A.M. | 2 P.M. | 3 P.M. |
|---|---|---|---|---|
| | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* |
| Outside temperature | 25 | 28 | 28 | 28 |
| Temperature at warm-air flue | 106 | 102 | 100 | 105 |
| Average temperature of room | 72 | 72 | 72 | 74 |
| Temperature at vent flue | 72 | 72 | 70 | 70 |
| Cubic feet air entering per minute | 1,500 | 1,500 | 1,500 | 1,500 |

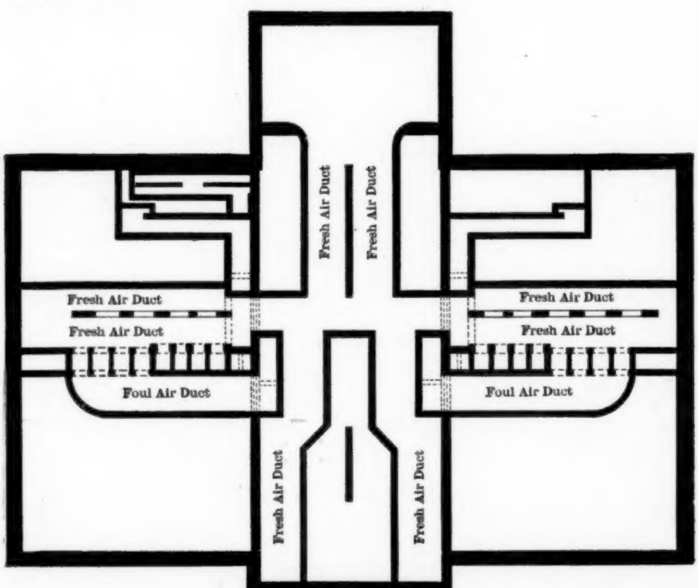
SOUTHWEST ROOM, SECOND FLOOR.

| | 9.30 A.M. | 11.30 A.M. | 2 P.M. | 3 P.M. |
|---|---|---|---|---|
| | *Degrees.* | *Degrees.* | *Degrees.* | *Degrees.* |
| Outside temperature | 25 | 28 | 28 | 28 |
| Temperature at warm-air flue | 118 | 110 | 110 | 108 |
| Average temperature of room | 74 | 74 | 73 | 72 |
| Temperature at vent flue | 64 | 66 | 60 | 62 |
| Cubic feet air entering per minute | 1,650 | 1,500 | 1,500 | 1,500 |

Foul air exhausted at vent at 2 p.m.:

Northwest room, first floor........ .....1,139 cubic feet per minute.
Southeast room, first floor...............1,235 " " " "
Northeast room, second floor........... 1,000 " " " "
Southwest room, second floor...........1,353 " " " "

The amount of coal burned from 8 A.M. to 4 P.M. on Dec. 17, was 504 pounds.




FOUNDATION PLAN

The amount of ashes taken out from 4 P.M. Dec. 16, to 4 P.M., Dec. 17, was 264 pounds. This would mean approximately 88 pounds for 8 hours or from 8 A.M. to 4 P.M. on Dec. 17.

This is equivalent to one pound of ashes to a little over 5½ pounds of coal.

## DISCUSSION.

Mr. Connolly: In the reading part of the paper, Mr. President, I believe Mr. Carpenter speaks about one ventilating stack and he has a stack heater in it. On the basement plan it shows four stack heaters at the base of the ventilating flues, and if this is so with the four furnaces and the four staircases and the portable furnace for the hall, it shows nine fires in the building. Without in any way disparaging hot air heating I think the schoolhouse would be better adapted for steam or hot water heating with one fire.

Mr. Fisher: I notice one peculiar fact in that on the first day's test the average temperature was some twelve degrees higher than on the second day's test, and the amount of fuel used on the colder day was about 12 per cent. less. Was that on account of windows being opened?

Mr. B. H. Carpenter: I think it is on account of the difference in the atmospheric conditions. While it was still cloudy the second day, the air outside was lighter than it was the day before.

Regarding the number of fires: there are seven. Four furnaces and one portable for the purpose of heating schoolrooms and halls, and two stacks for the purpose of ventilation.

To answer Mr. Barron. Some tests as to the amount of coal used were made about two years ago. One test was in a ten-room school building heated entirely by indirect steam, using about 360 square feet of indirect radiation to a room, and another in a similar-sized building heated by furnaces. Both systems were run by gravity during the test. The steam heated building had an engine and fan attachment so arranged that the heating system could be run by gravity or by blower. The tests were authorized by the building committee of a Pennsylvania school board, and were to continue for two days.

NOTE.—In weighing the ashes I found on the 16th that an even pailful weighed 26 pounds, and on the 17th only 20 pounds.

The building heated by steam used fifty bushels of buckwheat coal, and the building heated by furnaces used sixty bushels during the same period.

Mr. Lyman: May I ask if I understood Mr. Carpenter to say that he thought on account of the conditions of the atmosphere that although at higher temperature, the temperature ranging from thirty to forty degrees on the first day's test and the next day's test down to 35, with a northwest wind blowing, that it takes less coal to heat with the temperature at thirty-five than it did on the previous day at forty?

Mr. Carpenter: Yes, I believe that is it.

Mr. Lyman: It seems to be given so here.

Professor Kinealy: I would like to ask a question: In estimating radiating surface we estimate the number of heat units transmitted per hour. Now, how many heat units may we assume—and with some degree of accuracy—will be transmitted through a square foot of furnace heating surface?

Mr. B. H. Carpenter: We have given the amount of square feet of heating surface in this heater.

Professor Kinealy: I have tried to make an estimate on that and it seems to be in the neighborhood of 1,600 heat units per square foot of surface. What I asked you was, what did you use in estimating? In other words, suppose that we have to determine how large a surface to put in a building such at you speak of here where you have to supply so many thousand cubic feet of air per hour or per minute, and that air has to be raised from zero degrees to 110, 130, 140 or whatever is necessary to heat the building. Now, how many heat units will pass through the heating surface to this air per hour? If we know that, then at once we can calculate back and determine how big a furnace to put in.

Mr. B. H. Carpenter: The only thing we go by in that is the experience that we have had in the different cases. You do not find anything of the kind given in any of the manufacturer's catalogues. We try to keep a record of our tests.

Mr. H. J. Barron: I would like Mr. Carpenter to inform me of the comparative cost as between the method described and the method of heating with direct radiation. And then I would like to suggest that, whereas he has a number of fires there, at least equal to four fires, or to five, with a steam boiler

that work would be done with one fire, that is, with the ordinary steam apparatus.

Mr. B. H. Carpenter: I don't know that I can answer Mr. Barron's question. The only comparison that I have with me was the comparison which I have already made, showing that steam is slightly cheaper with the indirect than with the furnace system.

Mr. Barron: As I understand, the system simply burned a little less coal in that particular case. My impression is that the apparatus described by Mr. Carpenter would make the cost one-half of what the direct steam apparatus costs, and it is good practice to get records.

Mr. B. H. Carpenter: Do you want comparisons of costs of erection as between the system I have described and the direct system?

Mr. Barron: Yes, sir. Both systems have drawbacks. In this case I suppose they did not have money enough to pay for a hot blast system or an indirect system. It had to be a moderate priced system. And I think it is well for us to discuss the cost in general terms without getting specifically down to different prices. Engineers ought to know something about the cost.

Mr. B. H. Carpenter: I think the cost of direct steam plant would be less than the cost of this plant, on account of the flues. The brickwork in a building of this kind is quite an item; and I think a direct steam plant would be considerably less. As compared with indirect steam, giving the same ventilation, it would be the other way, because the brickwork in one would be about the same as the brickwork in the other, and the indirect steam plant would cost more than the furnace system. I should think the furnace system cost forty per cent. less than the indirect steam plant.

The President: If I might offer a suggestion at this time, perhaps Mr. Carpenter would be willing to do the same as Mr. Switzer did last year. He presented what was practically the same paper in a crude form. It was referred back to him with the request that he would give the Society more data. Perhaps Mr. Carpenter, if he was asked, might be willing to do the same thing, and then Mr. Carpenter might give us more data and submit what might prove to be a valuable paper in the end.

Professor Kinealy: How many square feet of indirect surface should be put into this building? If you could tell us that probably we would be able to make some estimate of the cost, and compare that estimate with the actual cost. In this building, on the 16th, in the morning, there was about 9,600 cubic feet of air per minute entering the room; in the afternoon, 14,560, an average of 12,000 cubic feet a minute during the day. Now, how many square feet of indirect surface would you put in to heat that 12,000 cubic feet of air per minute to the temperature heated by a furnace?

Mr. Carpenter: I judge about 360 square feet of indirect radiating surface to each school-room in the building would be about the average of what would be put in by an engineer in designing the apparatus.

Mr. Kent: I wish that Mr. Carpenter revise his paper for publication. If I wanted to heat a schoolhouse on this system I would be glad to have this paper as a reference from which to copy the constructive features. I could also read the paper and find out possibly what result I would be likely to get with reference to the outside or inside temperature. But if I should ask myself the question: "Here is a schoolhouse—what is the best way to heat it?" this paper would give me no information whatever. It draws no conclusions as to whether this system as a whole is desirable. I wish the writer of the paper would draw some conclusion, and not give us simply a statement that a certain schoolhouse was heated in this way. What did the tests mean? Did they mean that the results were good, bad, or indifferent? Or could they be improved, or would some other system be better? The questions engineers want to know about is, what kind of system to recommend, and then, after having the system defined, we could go to such papers as this for guidance. But I think every paper ought to have something to say by which we can form an opinion whether the system described is the right system.

Mr. B. H. Carpenter: With 100,000 cubic feet of space in the building, should you take the old rule of one foot to fifty, it would take about 2,000 feet of direct radiation, and you could make a comparison in respect to radiation. Direct radiation would cost a little more at that rate than the furnace system.

Mr. Barron: In the last fifteen years I have put up a dozen schools almost of this size, and whereas Mr. Carpenter says it would take 2,000 feet of radiation, I don't think we ever put in over 1,200 or 1,500. A man has to rough things out a little in looking at a proposition like this, and in every case where it was decided to heat by direct radiation it was done on the principle that those who did the work thought it was better than the furnace. The only advantage the furnace has is ventilation, and in all these cases the ventilation was thrown to one side, and the people were satisfied with direct radiation. I don't say that is right for schools, but it is the practical problem such as confronts us in all these various cases. I think myself that a direct radiating apparatus for this particular school, with one fire, would be much easier to attend to, and much simpler, and it would give as good general satisfaction. You would not have ventilation, but with this system there might be an argument that the ventilation is not of the best kind.

Mr. B. H. Carpenter: I think we are getting the fresh air just the same, and we are getting a quantity of it, and we have not had any complaints from gas. I saw a plant put up at one time that I regarded with interest. It was put up by one of our competitors, and I was called in some years later to make examination for repairs. Inside of the brick chamber two of the pipes had been connected and held together by driving a large nail through them. The nail had been removed, leaving a good-sized hole. I watched it, but never found a particle of gas coming from it. The air was always passing into the furnace rather than from it. There never was any complaint about sulphur in that building that I know of.

Mr. Barron: In this building a hot blast plenum system of ventilation could be put in for about thirty per cent. more than the hot air system described in the paper, and I think it would be just as economical in operation and would be more durable; and it would avoid any fear of ever having gas. There is no gas with the hot air furnace in the first few years, but the apparatus deteriorates in ten or fifteen years, and then the furnace is apt to leak. At least that is the experience of the trade with a furnace. And in heating a school of this kind, where ventilation is required, I think a hot blast plenum sys-

tem is superior to the furnace system, and I think where the building committee can spend thirty or forty per cent. more it is more desirable to use it.

Professor Kinealy: You have told us that a school building of this size would require for direct radiation without ventilation in the neighborhood of 1,000 to 1,200 square feet of radiating surface. The result of the investigations I have made on school buildings lead me to believe that the amount of heating surface necessary to supply the heat lost through the walls is a very small proportion of the total. The great amount of heat is used in heating the air supplied for ventilation, and when you put into a school-room in the neighborhood of 1,800 or 2,000 cubic feet of air per hour for the pupils, and raise that air from zero, or even ten below zero, up to seventy degrees, it requires a great deal more heat than is lost through the walls and windows to the outside air. I remember one school, where I had to make an investigation and report, in which furnaces were installed, and I carefully calculated the amount of heat lost through the glass, through the windows and walls, and also the amount of heat that had to be supplied to raise the temperature of the air from zero up to seventy degrees—air supplied for ventilation. About one-fourth of the total heat supplied was the heat that passed through the walls and windows to the outside air; three-fourths of it had to be supplied to heat the air supplied for ventilation. Now, if that will hold good for this school, and if we must put in a thousand square feet of direct steam surface to supply the heat lost through the walls and windows, then we would have to put in for ventilation something like 3,000 square feet, making a total of something like 4,000 square feet of direct radiating surface. At a dollar a foot that would be $4,000.

I ask for information because I have been up against this very problem of furnace heating two or three times, and I cannot get information in regard to furnaces. Frankly, the furnace men either won't give it, or they cannot give it.

Mr. Barron: They do not have it.

Professor Kinealy: Well, I don't know. I can't get it. I need it, and I want it.

Mr. B. H. Carpenter: We would like to have it very much. I have asked two manufacturers if they would give us the in-

formation of their own furnaces. They said they thought they could sell just as many furnaces without, and that the greater portion of their buyers would not know anything about it if they did. So they have not obtained any data. I think the furnace systems vary much more than the steam or hot water heater. A tabulated form could be gotten out, I presume, if enough attention was paid to it. I could not even get from the manufacturer of this furnace the amount of direct fire surface.

Mr. Kent: I would like to ask Mr. Carpenter if he will put in his paper some statement about the amount of air delivered into the different rooms, whether it was satisfactory. I find on page 6, "in the southeast room, first floor, at 10 o'clock in the morning, there was 1,070 cubic feet of air entering per minute; in the northeast room, second floor, 1,687 cubic feet per minute." I would like to know which of these two figures was the most desirable. If 1,070 is right, it is burning more coal than is necessary in the northeast room. I thought it might be due to the position of the room, whether northeast or southeast. But turning to page 10 I find that the reverse is true, that the southeast room gets the more air, whereas in the first case it got the least. The figures run up to 2,100 cubic feet, at 9:30 A.M., in the southeast room; and in the northeast room 1,500 cubic feet are given. Here we have a variation from 1,070 cubic feet of air entering per minute in the southeast room, at 10 o'clock in the morning (page 6) to 2,100 feet in the same room on the next day, at 9:30. Which of these two are right?

Mr. B. H. Carpenter: Fifteen hundred cubic feet per minute was the amount we were trying to give. Of course it is impossible, taking the temperature as it was, 28 degrees outside on the second day, and 40 degrees on the first day, on the gravity plan to get the same amount of air. The only change we can make in the building is to vary the heat of the stack heater. We must have sufficient heat in the furnaces to warm the room, and the difference of heat in the stack heater will assist somewhat in averaging up the amount of air for the rooms. This was one of the worst days that the test could be made in, it being a warm, heavy, rainy day.

Mr. Kent: I wish Mr. Carpenter would put these statements

into his paper, and if we could have a test when the temperature was 62 degrees outside, he would probably find no air at all entering, that is, on the gravity system, and the children would not get fresh air unless you opened the windows. But I think the complete exposition of this whole subject would lead to the general conclusion: Don't put in this kind of system.

Mr. Quay: What I have to say is probably not quite on the subject. You have noticed that we have had a great many papers and a great deal of discussion on furnace heating at our different meetings, and yet after all this discussion and all these papers we have scarcely any accurate data. It seems to me that it has gone far enough, and it might be well to appoint a committee of three to get all the information they can, and to bring in a report on some of these vital questions that have been brought up for and against furnace heating, say, at our next meeting. I think by that means we might get some accurate data on these questions.

Mr. H. A. Joslin: Mr. Maloney, from Connecticut, is here. He is superintendent of school buildings there, and in the last two years he has contracted for three or four twelve-room schools to be heated by hot blast.

Mr. Maloney: I would not undertake at the present time to give Professor Kinealy the exact figures as regards the installation of various systems that we have installed, but if the Professor would like it, I will, within a week, send him an exact statement of the cost and the results of some of the anemometer tests taken on these buildings within the last three years. And I will say this in regard to New Haven, in reference to the possible appointment of such a committee as has been referred to, that nothing would please me much better than to have that committee, if it could, visit New Haven, for the reason that in that city we have such a variety of heating plants, in our buildings, and such a similarity in the size of the buildings, that the information which this Society would like would be very easily obtained there. And New Haven being near to New York I don't think it would be a great deal of trouble for the committee to come, and I would be only too willing to devote my entire time to the gentlemen if they should see fit to visit the city. I can say, that our last building, which was completed in November, is an eighteen-

room building. The rooms, to the best of my recollection, average 30 x 26 feet, $12\frac{1}{2}$ feet in the clear. That building is heated by six furnaces, with a six-foot blower, and the contract price, to the best of my recollection now, was $3,700. The building preceding that, which was a twelve-room building, built with the possibility of raising it another story, was also heated with six furnaces, and I think on account of a conflict between the contractors we got somewhat of a bargain sale on that job. We got identically the same plant in the building for $2,800. And in regard to the lay-out which Mr. Carpenter has submitted here, we had a building in New Haven heated with exactly the same furnace, the building itself differing to this extent that it is a three-story building instead of two. And in regard to the construction of the ducts, we had none carried underground, but large air chambers for each set of furnaces. But while we have twelve-room and eight-room buildings heated with furnaces, at the same time we have twelve-room buildings heated entirely with steam. And we have others, all built within a very few years.

Mr. Quay: I would like to ask whether these prices included the constructive portions of the work in the building?

Mr. Malony: No. All masonry work was in the mason contractor's work. The heating contractor of the building set the furnaces and constructed all galvanized iron work, and so on, but all our masonry work in the building is included in the mason contractor's work.

Mr. C. E. Oldacre: I wish to ask Professor Kinealy what is the character of data that he wishes from the hot air people? I myself have been and am carrying on a certain investigation along that line, and I have some data which have not been published, and about which some have said that either the furnace man has not got them or keeps them under his hat all the time. If he could give me an idea of the character of the data he wants it would be a great help to me in deciding exactly in what line to carry further investigation. I am aware that the furnace manufacturer either does not know what his goods will do or does not want to tell. Perhaps, as in a good many cases, the rates are too high and will not bear examination.

Professor Kinealy: I want to know:—

First. How many heat units would be transmitted by one square foot of furnace heating surface under a natural draught?

Secondly. How many heat units would be transmitted by one square foot of furnace heating surface under a forced draught when the blower is used?

Thirdly. Is there any difference between the transmission of cast iron and wrought iron, under the same conditions?

Mr. Oldacre: I thank Professor Kinealy very much for giving me an idea of the questions that he desires to have answered. And I would say that that is very much the line on which I am carrying on my experiments; but offhand, as I have none of my experiments tabulated here I could not give him any information, and I would not wish to give any infortion until I have satisfied myself that what I am after is more particularly the character of data he is looking for. It is simply a matter of the line of investigation to follow. I have followed some of Professor Kinealy's formulæ which he has given to the public, and I will say frankly that they have been of guidance to me, and I would like to add that I think it is possible, if he wants it, to distinguish between flue surface and fire surface as well. Some claim that certain heaters are made up of a great deal of flue surface, others of a great deal of fire surface; and in some cases the fire surface is exposed to the action of the air, while in other cases the surface is such that the fire strikes it but the air does not.

Mr. B. H. Carpenter: I would like to ask of Mr. Kent if his criticism of this system would not apply to steam or hot water?

Mr. Kent: It would for school purposes. For schools I think the only system is the forced draft system with a fan. The only thing to do is to put in a fan and blow the air.

Mr. B. H. Carpenter: One other point. One summer I made a test in warm weather of the ventilation of a school on the gravity plan, and the result surprised me. By keeping the stack heater very hot we got from 1,200 to 1,500 cubic feet of air per minute in each room.

Professor Kinealy: I tried to get some data in regard to indirect steam. Roughly speaking, it seems to me that it would require about 3,000 square feet of steam surface. That would be in the neighborhood of $3,000. Now, the furnace system, as I understand, costs considerably less.

## CVII.

# TEST OF A CAST IRON HEATING SURFACE IN CONNECTION WITH THE FAN SYSTEM OF HEATING.

BY R. C. CARPENTER.
(Member of the Society.)

At the present time the heating surfaces employed in fan systems of heating are almost exclusively made from one-inch wrought iron pipe, although in nearly every other system of heating cast iron surfaces are almost universally employed. For ordinary systems of direct and indirect radiation the cast iron surface has proved to be practically as efficient as that made from wrought iron, and on account of its lower first cost and greater durability it has come into almost universal use.

The heating system, the test of which is referred to in the title, was arranged especially for the experiment by the American Radiator Company and consisted of 12 radiators, each composed of 21 sections arranged in 2 vertical rows; that is, 1 set of radiators, 6 in number, was placed on top of the others. Each section was a single casting in form of four tubes, approximately triangular in cross section and slightly staggered, connected top and bottom, as shown in Fig. 1. The dimensions of each section over all was 9 by 36 inches, with one-half-inch air spaces between the tubes. Twenty-one sections were connected at the top and bottom so as to form a radiator or heater. The heating surface as measured by ourselves was 6.7 square feet per section, or a total of 1,688.4 square feet.

The fan employed drew the air over the heating surface by by suction and discharged it into a small chamber and thence through a delivery pipe and nozzle into the room. The entering air passed between 42 cast iron sections arranged, as described, in 12 radiators. The heater was approximately equivalent to a pipe heater containing 21 tubes arranged trans-

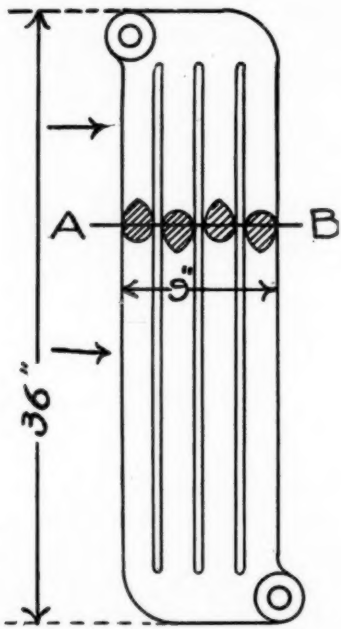



FIG. 1.

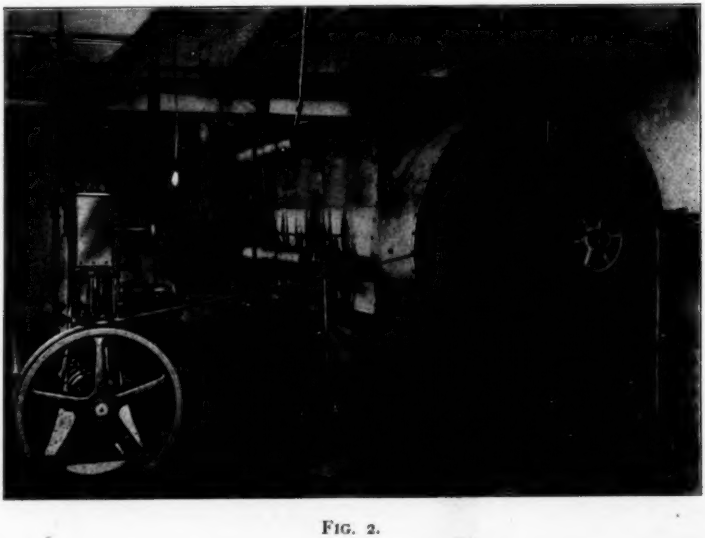


FIG. 2.

versely to the direction of the air current and 24 tubes arranged parallel to the air current.

The 6 radiators composing the upper half of the heater and also the 6 composing the lower half were arranged so that

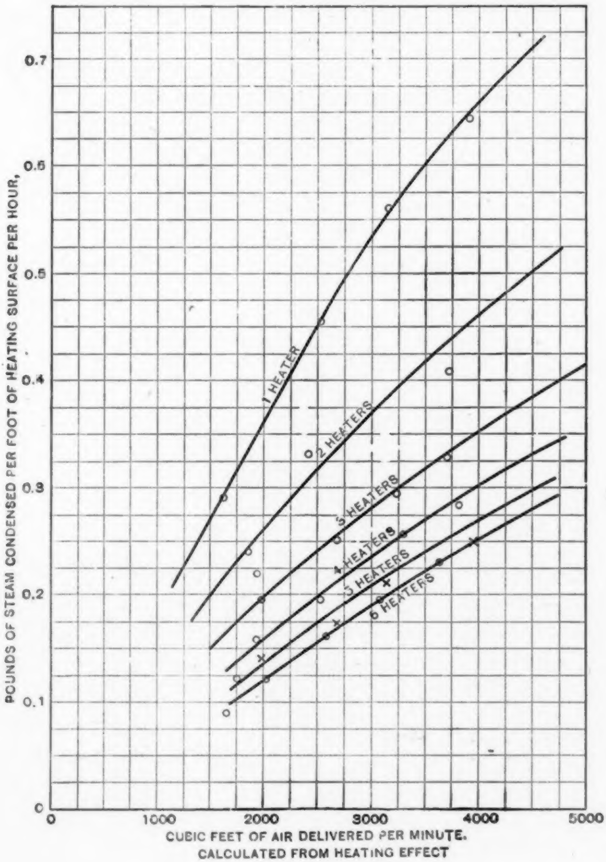



FIG. 3.

steam could be supplied independently, and tests were made with different numbers of sections in use. In each test, however, the same number of sections in the upper and lower part of the heater were employed.

The fan used was made by the American Blower Company

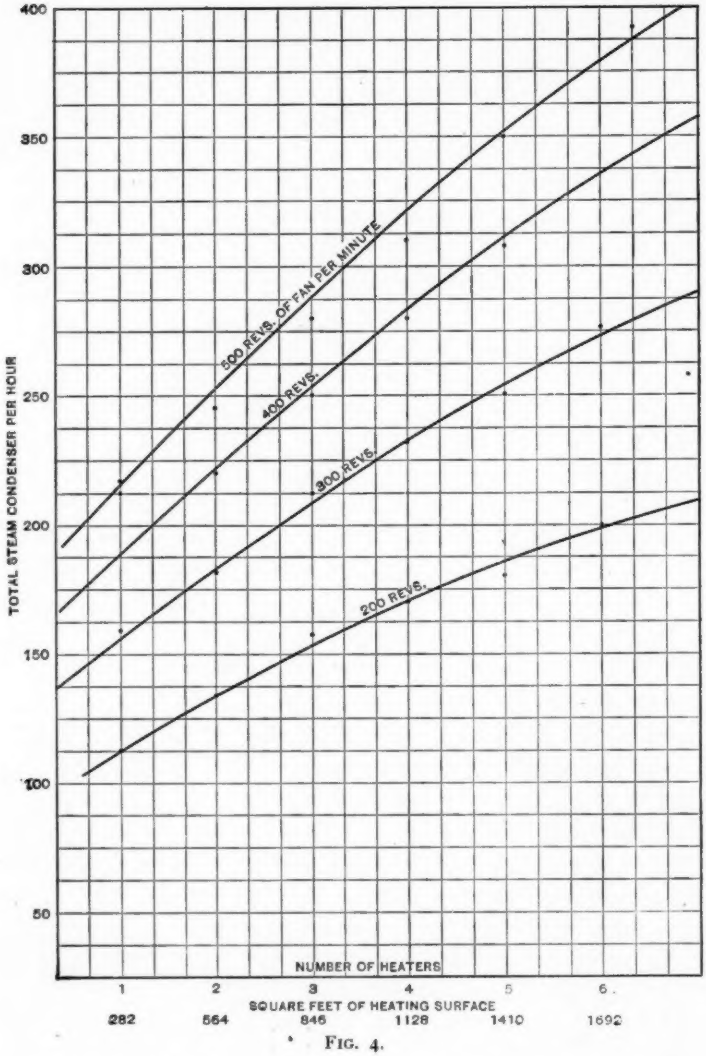



FIG. 4.

and had the following dimensions: Height over all, 80 inches; diameter of wheel, 48 inches; width of periphery, 17.5 inches; inlet diameter, 30 inches; outlet, 27 by 27 inches. The fan was driven by a vertical engine 6 by 6 inches. The general arrangements for the test are shown by the photograph, Fig. 2.

The general results of the test are shown in the table and also in the various diagrams accompanying the report.

The results show a considerable resistance to the passage of air into the fan, so that much less air was delivered per

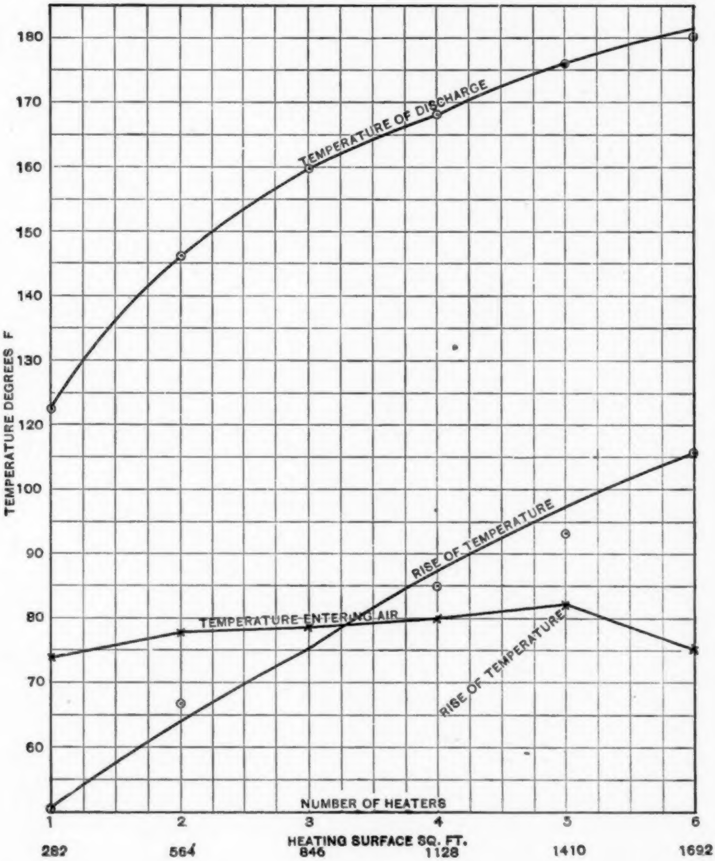



FIG. 5.

revolution than would ordinarily have been the case with heating surface composed of 1-inch pipe. The capacity or power of transmitting heat per square foot of surface for a given number of revolutions of the fan is less than would have been obtained with a heating surface made of 1-inch pipe.

The same results would doubtless have followed the use of a heater made of wrought iron pipe with a restricted passage for air.

It follows from this that, although this test shows much lower results than is usually obtained with a heater made of inch pipe in blower systems of heating, it cannot be considered

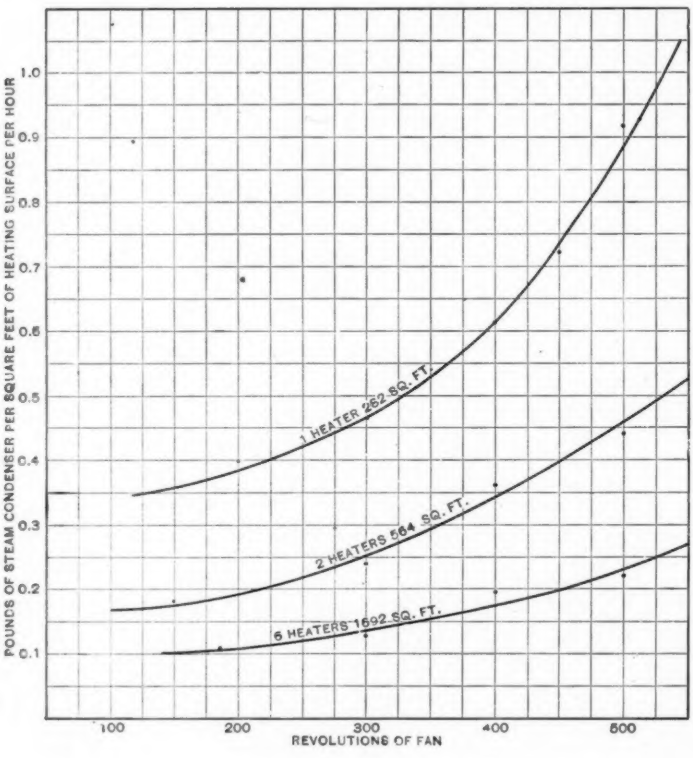



FIG. 6.

proved that a properly designed system of cast iron heaters would not be equally as efficient for blower systems of heating as one made of wrought iron pipe.

The table gives the average value of all the results as obtained in the various tests.

Fig. 3 is a diagram showing the relation existing between

# RESULT OF TESTS.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Number of run | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 2 Number of sections of heaters | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| 3 Heating surface square feet | 282 | 282 | 282 | 282 | 282 | 564 | 564 | 564 | 564 | 564 | 846 | 846 | 846 | 846 |
| 4 Absolute pressure of steam, lbs | 24.69 | 24.81 | 24.81 | 24.81 | 24.81 | 24.69 | 24.87 | 24.77 | 24.77 | 24.77 | 24.81 | 24.81 | 24.81 | 24.81 |
| 5 R. P. M. of fan | 161. | 226. | 303. | 399.5 | 500.8 | 155.4 | 201.8 | 304.1 | 403.1 | 501.5 | 205.3 | 302. | 406.5 | 502. |
| 6 Pressure in inches of water, static head | 0.207 | 0.412 | 0.797 | 1.407 | 2.294 | 0.203 | 0.31 | 0.774 | 1.397 | 2.21 | .314 | .746 | 1.37 | 2.167 |
| 7 H. P. consumed by fan | 0.3872 | 0.5886 | 1.182 | 2.249 | 4.178 | .0997 | .3401 | 1.122 | 2.472 | 4.17 | .3269 | .864 | 1.904 | 3.774 |
| 8 Velocity head of discharge, ins. of water | 0.184 | 0.388 | 0.780 | 1.386 | 2.29 | 0.193 | 0.286 | 0.763 | 1.865 | 2.18 | .291 | .733 | 1.345 | 2.15 |
| 9 Pounds of steam cond. per hour | 82.5 | 129. | 158.3 | 182.4 | 213.5 | 123.5 | 137 | 188 | 215 | 230 | 166 | 212 | 250 | 279 |
| 10 Ditto per sq. ft. of heating surface | 0.293 | 0.456 | 0.561 | 0.645 | 0.721 | 0.22 | 0.242 | 0.334 | 0.382 | 0.408 | 0.196 | 0.251 | 0.296 | 0.33 |
| 11 Temperature of air received | 73.6 | 75.3 | 73.4 | 72.0 | 72.3 | 81.0 | 70.1 | 81. | 80.1 | 83.0 | 74.1 | 79.1 | 81.4 | 86.2 |
| 12 Temperature of air delivered | 125.1 | 127.2 | 124.6 | 120.9 | 118.8 | 143.7 | 144.7 | 150.4 | 148.0 | 146.1 | 158.9 | 159.1 | 159.2 | 160.3 |
| 13 Rise in temperature of air | 51.5 | 51.9 | 51.2 | 48.9 | 46.5 | 62.7 | 74.6 | 79.4 | 67.9 | 63.1 | 84.8 | 80.0 | 77.8 | 74.1 |
| 14 Temperature of water leaving coils | 211.7 | 190. | 189.4 | 191. | 186.7 | 215.6 | 198 | 205. | 212. | 209. | 207.4 | 206.3 | 206. | 203.4 |
| 15 B. T. U. withdrawn per hour by cond. steam | 14820 | 20200 | 24900 | 29200 | 33000 | 23680 | 23750 | 3282 | 38740 | 40750 | 29150 | 36950 | 53500 | 47800 |
| 16 B. T. U. given off per hour by steam | 80430 | 127600 | 156800 | 180000 | 211800 | 117520 | 133250 | 183280 | 207560 | 223751 | 161150 | 206050 | 243500 | 272600 |
| 17 Weight of air discharged per minute, lbs | 109 | 170 | 214 | 258 | 318 | 132 | 125 | 163 | 212 | 253 | 134 | 182 | 219 | 257 |
| 18 B. P. U. per sq. ft. heating surface per hour | 285.3 | 452. | 556. | 639. | 750. | 208.5 | 236. | 325. | 368. | 397. | 190.5 | 237.8 | 288. | 322.8 |
| 19 Velocity of discharged ft. per minute, measured | 1992 | 2669 | 3529 | 4386 | 5813 | 2015 | 2458 | 2530 | 4570 | 5900 | 2473 | 3560 | 4513 | 5890 |
| 20 Velocity of air entering coils ft. per minute, measured | 234 | 313 | 412 | 513 | 683 | 233 | 277 | 401 | 519 | 675 | 273.5 | 398 | 488.5 | 666.5 |
| 21 Cu. ft. of air delivered per min. calculated from heating effect | 1605 | 2510 | 3150 | 3806 | 4700 | 1940 | 1840 | 2400 | 3120 | 3720 | 1970 | 2680 | 3220 | 3710 |
| 22 Ratio of expansion of air | 1.095 | 1.095 | 1.097 | 1.078 | 1.090 | 1.116 | 1.038 | 1.128 | 1.126 | 1.120 | 1.159 | 1.150 | 1.144 | 1.134 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Number of run | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 2 Number of sections of heaters | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 |
| 3 Heating surface square feet | 1128 | 1128 | 1128 | 1128 | 1128 | 1410 | 1410 | 1410 | 1410 | 1692 | 1692 | 1692 | 1692 | 1692 |
| 4 Absolute pressure of steam lbs | 24.69 | 24.81 | 24.75 | 24.47 | 24.47 | 24.84 | 24.75 | 24.79 | 24.79 | 24.69 | 24.77 | 24.77 | 24.77 | 24.77 |
| 5 R. P. M. of fan | 159.6 | 202.5 | 301.5 | 402.2 | 502.4 | 203. | 304. | 402. | 501. | 154.1 | 211.5 | [illegible]02.08 | 403. | 493. |
| 6 Pressure in inches of water, static head | 0.173 | 0.329 | 0.733 | 1.30 | 2.08 | 0.32 | 0.74 | 1.32 | 2.07 | 0.197 | 0.334 | 0.743 | 1.31 | 2.08 |
| 7 H. P. consumed by fan | .2249 | .323 | 1.003 | 2.124 | 4.12 | .367 | .778 | 2.095 | 3.38 | | | | | |
| 8 Velocity head of discharge, ins. of water | 0.167 | 0.298 | 0.724 | 1.273 | 2.05 | 0.28 | 0.72 | 1.29 | 2.04 | 0.193 | 0.30 | 0.718 | 1.27 | 2.04 |
| 9 Pounds of steam cond. per hour | 139.5 | 179 | 220 | 289 | 320 | 198 | 246 | 296 | 352 | 151.5 | 208 | 275 | 338 | 391. |
| 10 Ditto per sq. ft. of heating surface | 0.123 | 0.159 | 0.195 | 0.256 | 0.284 | 0.140 | 0.174 | 0.21 | 0.25 | 0.09 | 0.123 | 0.163 | 0.187 | 0.232 |
| 11 Temperature of air received | 80.0 | 81.7 | 83.9 | 81.0 | 80.0 | 69.9 | 86.6 | 85.6 | 91.4 | 84.4 | 78. | 77.0 | 75.0 | 74.0 |
| 12 Temperature of air delivered | 159.4 | 172.5 | 169.4 | 166.1 | 164.4 | 172.3 | 177.6 | 176.6 | 177.8 | 174.1 | 182.5 | 182.3 | 180.8 | 179.2 |
| 13 Rise in temperature of air | 79.4 | 90.8 | 85.5 | 85.1 | 84.4 | 102.6 | 91. | 91.0 | 86.4 | 89.7 | 104.5 | 105.3 | 105.7 | 105.2 |
| 14 Temperature of water leaving coils | 219.6 | 209.6 | 208.9 | 209. | 203. | 199.6 | 204.2 | 219.1 | 216.4 | 216.2 | 213.1 | 215.1 | 212.1 | 212.3 |
| 15 B. T. U. withdrawn per hour by cond. steam | 26180 | 31790 | 37850 | 51200 | 54750 | 33200 | 42350 | 55400 | 64930 | 27950 | 37750 | 50400 | 60000 | 70500 |
| 16 B. T. U. given off per hour by steam | 134020 | 173511 | 214550 | 278800 | 311550 | 193600 | 240350 | 283600 | 338070 | 145800 | 200650 | 264600 | 321800 | 377500 |
| 17 Weight of air discharged per minute, lbs | 119 | 134 | 175 | 228 | 265 | 136 | 186 | 217 | 275 | 114 | 139 | 177 | 213 | 250 |
| 18 B. P. U. per sq. feet heating surface per hour | 118.8 | 154. | 190.5 | 246.5 | 276.5 | 137.3 | 170.5 | 201.0 | 240. | 862. | 118.3 | 156.4 | 190 | [illegible]23. |
| 19 Velocity of discharged ft. per minute, measured | 1992 | 2520 | 3500 | 4640 | 5960 | 2518 | 3570 | 4670 | 5980 | 2022 | 2580 | 3060 | 4680 | 5960 |
| 20 Velocity of air entering coils ft. per minute, measured | 221 | 277 | 389 | 515 | 662.5 | 270 5 | 393.5 | 514. | 663.5 | 222. | 277.5 | 382. | 502.5 | 640 |
| 21 Cu. ft. of air delivered per min. calculated from heating effect | 1730 | 1940 | 2520 | 3300 | 3830 | 1960 | 2690 | 3140 | 3980 | 1650 | 2005 | 2560 | 3075 | 3610 |
| 22 Ratio of expansion of air | 1.148 | 1.165 | 1.157 | 1.156 | 1.156 | 1.198 | 1.164 | 1.168 | 1.158 | 1.168 | 1.198 | 1.196 | 1.197 | 1.198 |

the speed of the fan and the steam condensed, in pounds per hour, for different amounts of heating surface.

Fig. 4 shows in a similar manner the relation between the heating surface and the steam condensed for different speeds of the fan.

Fig. 5 shows the relation between the temperatures of entering and discharge air.

Fig. 6 shows the relation between the speed of the fan and the steam condensed per square foot of surface per hour, for different amounts of heating surface.

I was assisted in the test, the results of which have been given you, by Messrs. Neave and Cazenove, graduate students in the university.

## DISCUSSION.

Mr. Clarence Lyman: I noticed in the Professor's report of the condensation that when the fan was running at a velocity with one section, at 500 revolutions, the condensation was nine-tenths of a pound to the square foot; at 300 revolutions, forty-five one-hundredths, or just about one-half the condensation; while at 200 revolutions there was only a drop of four-tenths of a pound. I would like to ask the Professor how he would account for that difference.

Professor Carpenter: I have, in connection with the diagram, drawn up a series of lines, in which I have taken directly from the records of the tests the total condensation, which is given in pounds. We find, with the number of revolutions of the fan increasing in this direction, we had these different lines, for the single heater, the double heater, the triple heater, the quadruple heater, and the rest. They all increase in just about the same manner, but the rate of increase is different for different conditions, and these lines apply to the actual observations that were taken.

Mr. S. A. Jellett: From the description which Professor Carpenter has given us of a cast iron radiator used in this form I reached the conclusion that we shall have to have an entirely different form of cast iron radiator if we are going to compete with the old one-inch pipe. The form of radiator itself is not adapted to meet the case. With inch pipe, when you have four pipes in a row, each pipe is staggered. In this particular

case each radiator staggers and you only get a stagger every four rows.

Professor Carpenter: Each pipe is staggered in the same section.

Mr. Jellett: The difficulty I see in this form is that there would be clogging of condensation, because the return, instead of being directly into the base from each vertical tube, is from each four tubes coming down and joining into one. The sections nearest to the fan, under these conditions, would be probably choked with condensation. It would be a very difficult thing to clear it, unless there were specially large spaces made with these radiators. With the inch pipe the condensation falls directly to the base, and the first section, of course, does the heavy work. The second objection I see to it is this: If you take an inch pipe put into a cast iron base, it is a case of screwing a pipe directly into the base, and the only corrosion that can take place is the corrosion that accompanies any standard pipe. But in this case, with the cast iron radiator, there is contraction and expansion going on all the time in addition to the effect of the condensation, which makes me believe that the life of such a heater would not be very long. I think if cast iron sections are to take the place of the wrought iron pipe, under the extreme conditions met with in the fan system, there would have to be a different form of cast iron radiator used, one that will clear itself rapidly, and made up of small units, that can be screwed directly into a base, so that it may clear itself at once. The air space would have to be larger, too. On the whole, I think there would have to be a very different form of cast iron radiator to compete successfully with the inch pipe in the usual form.

Mr. Bishop: There is a style of radiator made with no nipples, where the bolts run through the sections. I built a stack putting up 100 sections, a year ago, divided into eight stacks, really, and we had no difficulty in keeping it tight throughout. And that was made up with an arrangement which breaks up the surface.

Professor Carpenter: I might say that in connection with the first attempt to make these, after we had the radiator put up and turned the heat or the steam on, we broke one of the main headers supplying the radiators with steam. This, I

think, was due to expansion. We had considerable difficulty in repairing it. But after we got it fixed it stood very well.

Mr. Blackmore: Did you make any attempt to force the air through in your experiments?

Professor Carpenter: No. The only fan we had available was the one arranged as I described. I think, however, the results would have been just the same the other way. We should have had great air resistance.

Mr. Blackmore: Have you reason to believe that it would have done better work if the tubes had been staggered?

Professor Carpenter: These (indicating on diagram) were staggered. If we had had inch air space instead of one-half inch it would have done much better.

Mr. Blackmore: You believe in the stagger idea?

Professor Carpenter: Yes, sir. But the trouble was in the size of the passage for the air. The result was that it choked the fan.

Mr. B. H. Carpenter: I would like to ask Professor Carpenter what would be the probable condensation, in his judgment, with 500 revolutions of the fan, if, instead of using the two banks, one above the other, the same amount of radiation was used but spread out in one bank.

Professor Carpenter: If I understand the question, it would require the radiators to be placed back to back, and we would have twelve of them instead of six. We had six in this case. If we had twelve right along, one after the other—if that is the question—it would cut off the efficiency very much, because we found in our tests that as we increased the number of sections through which the air went, the condensation was decreased very rapidly, because the air gets hotter and hotter as it goes from front to back, and its power of condensation is very much less. In some tests which we made a few years ago on wrought iron surfaces, we were led to believe that it was not commercially profitable to use more than about sixteen inch tubes for the air to pass through. Of course those are set staggering, and placed about an inch apart, because we found that the amount of gain in heat after it had passed through sixteen tubes was exceedingly small.

Mr. B. H. Carpenter: I will put the question differently.

Instead of making a long passage of air, make it shorter, but spread it over more space, so that it comes in contact with more heating surface, but passes through but one stack of radiators.

Professor Carpenter: I feel very sure, in that case, we should have increased the efficiency, because one of the objections to this system seems to have been that we did not have room enough for our air. If we could have put more than twenty one sections in a row, and a lesser number back to back, we should have made more room for air for the fan, and I feel sure we should have had a considerably higher efficiency.

Mr. B. H. Carpenter: Mr. Henry I. Snell is with us. He has had some experience with cast iron radiators, and I should like to hear him.

The President: The Society would be glad to hear from Mr. Snell.

Mr. H. I. Snell: I hardly feel like saying anything. I have not heard all the paper read. So I do not know the position Professor Carpenter has taken, or the results which he reached. The experience which I have had with cast iron radiators is quite limited. I felt at one time as though I wanted to get up something which would do a little better than we could do with the pipe radiator, and some fifteen or twenty years ago I went to work and constructed a radiator for the purpose of experiment, using what was then known as the Westfield section. It was a straight section and corrugated, that is, it had bands running around it, and they ran half-way round and then they broke joints, and I think the corrugations were placed about one inch apart, and this break in joints made them about half an inch apart. The reason why I selected that was because I could subdivide the space as much as possible. I built a section of that, giving me an area for the fan which I was proposing to use, and the results that I got on that occasion, which were gradually but quite carefully obtained, were very satisfactory indeed. I was able to heat the air that passed through—or the resultant air that came out from the end of the pipe after passing through the heater—I was able to get a higher temperature of the air than I have been able to get with the wrought iron pipe. My theory of the reason of that was that I had subdivided it so that my spaces

practically were not more than half an inch square many of them, but they were placed so that these corrugations were lapping into each other, so that I had spaces that air was passing through of not more than about half an inch square. And from my experience my judgment was that the air, in order to be heated, has got to come in contact with the heated metal, otherwise it would pass through without becoming heated at all, and the total amount of heat units passing through might be equal in number, but the resultant temperature would not be so high. There might be any volume of air passing through, so that the units of air might be as large, or perhaps larger, than the difference in the spaces. And this result led me to think at the time that I should go to work and make more extended experiments, but business occupations and one thing and another prevented it, and I never made any very extended experiments on that subject. Now, whether that harmonizes with the results of Professor Carpenter's experiments I do not know. Whether he found that he got an increased temperature by the use of cast iron and smaller divided spaces or not I do not know, as I did not hear his paper. But there are other things besides that in regard to the use of the heaters. The advantage of the pipe system is that anybody can repair it. Anybody can put a pipe in it if it is out in the western wilds of Minnesota or anywhere. There is no danger that I know of from expansion or breaking pipes, because the pressure is generally low pressure, exhaust steam. The effect that we do get with the wrought iron pipe with exhaust steam is about 140 degrees of temperature of the air after coming out when the heater is working properly under its best efficiency. I got it up to nearly 170 degrees.

Professor Carpenter: I think I got 182 degrees. Mr. Snell has brought out something which I did not say anything about. That is the temperature of the air. I may mention the fact that we had considerable more resistance on the fan and did not get anywhere near the air we would have got with the heater made of inch pipe, with the same number of revolutions. But we did get a very much higher temperature. That I did not say anything about. Mr. Snell has brought that out. We had, for instance, a maximum temperature of

180 degrees, with the six sections; 178 degrees with the five heaters in use. The cast iron section tried was one of peculiar make, having a section of this form (referring to diagram, Fig. 2). There were twenty-one of these sections. Now, with six of these in use we got 180 degrees. They were slightly staggered. With three tubes we got a temperature of 160 degrees, so that we did get very much hotter air, but very much smaller quantities, and I criticised it on that account.

Mr. Snell: I should think that might be remedied by making the breadth of the section more, so that the free air through there could be in any quantity you wanted.

Professor Carpenter: I think that would be a great improvement.

## CVIII.

# SMOKE AND GAS-FLUE SYSTEM IN THE ANSONIA APARTMENT HOTEL, NEW YORK.

BY REGINALD PELHAM BOLTON.

(Member of the Society.)

In the course of the construction of this great building, which contains 340 suites of apartments, and more than two thousand rooms, the writer, who had designed the system of ventilation of the apartments, was called into consultation upon a difficulty that had arisen with regard to the construction of the parlor and bed-room chimney flues. The building contains 63 fireplaces in each apartment floor, and 12 kitchen gas ranges, making 1,133 in all, inclusive of those in the ground floor.

The difficulty in providing flues for the large number of superimposed fireplaces, necessitating, under usual methods, not less than 268 separate flues, was complicated by the fact that most of the rooms were so designed that the respective fireplaces were situated on interior partitions, others were placed back to back, and in general they were planned to occupy a corner of a room. In almost every case, therefore, a line of flue in wall or partition cut the lines of steel framing, and, if placed to one side of the latter, required separate framing to carry its load, and in addition as the flues were added on upper stories, seriously encroached on room space. The flues had been planned in detail, and were so proportioned that four fires were served by each flue. In order to avoid the framing, and especially that due to the change of outline by the mansard roof, they were required to be offset and twisted in a most complicated and undesirable manner.

In addition, the two upper apartment floors, 15 and 16, are reduced by the receding shape of the mansard roof, and not only lost most important space by the bulk of the stacks, but

the outer flues themselves were required to be built at an angle on the fifteenth to suit the shape of the outer walls.

A still further difficulty presented itself in the impracticability of connecting the interior fireplaces of the sixteenth floor to the outside chimneys. The connection of the latter to the building being at the level of the seventeenth floor, the interior flues had to be carried over horizontally across the ceiling of the sixteenth floor, thus rendering them practically worthless.

The entire system as proposed seemed to present so much special work as to be very costly, particularly in the special framing and offsets rendered necessary. A study of the conditions led the writer to propose a radical departure from ordinary methods, which has been successfully installed.

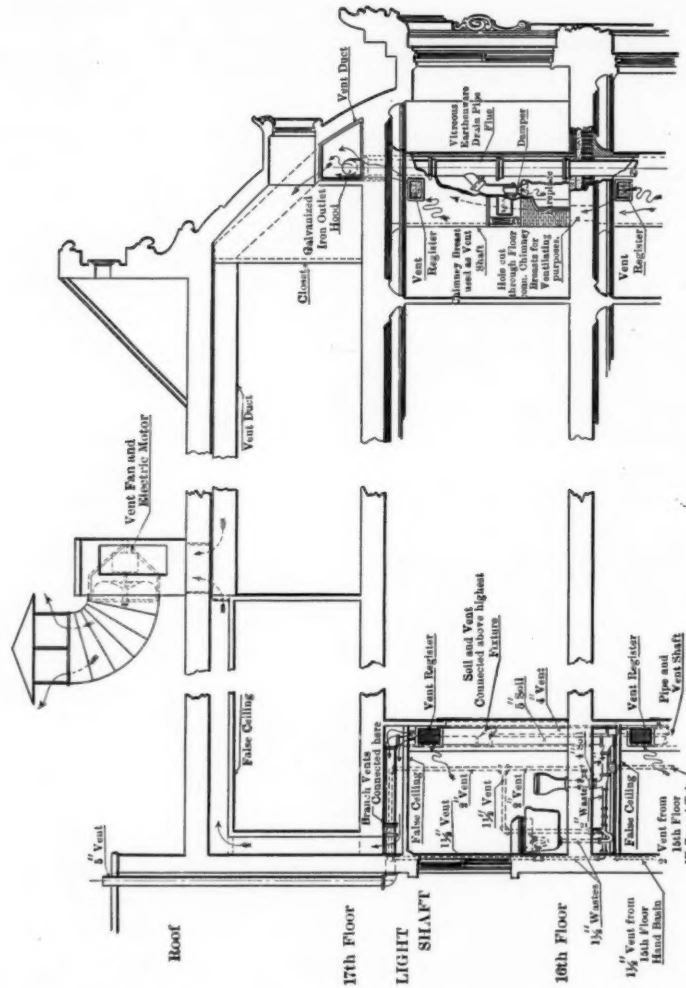
It consisted in the abandonment of outside chimney stacks as a means of disposal of the gases and the connection of the smoke flues and vent fans on the roof, whereby a definite draft would be maintained in any fireplace. By combining the gas-range flues with their vents, similar results could be effected in the kitchens. The arrangement obviates the necessity of separate flues for limited numbers of outlets, and enables a long line of fireplaces to be connected to one flue.

The adjustment of draft could be readily set by a fixed damper at each smoke inlet.

Advantage was taken of the existing system of vents already designed and partly installed for the above purposes, the vent fans, of which there are 5, being increased in size to suit the additional work imposed upon them.

The apartments are ventilated by a supply of tempered air, delivered from flues under pressure, inside the private corridor of each apartment suite. The escape for the air there introduced is provided by vent registers in flues passing through each toilet room, bath room and kitchen, in the latter use being wanted high up under the hood over the gas range. In addition, in each parlor or bedroom, a vent was provided over the chimney-breast, these being connected into the space behind the breast, with connecting holes through the floors. Each line of chimney-breasts therefore forms a vent shaft.

Every bath room has a vent shaft or flue formed in one of the outside corners, by furring out around the stacks of sanitary, water and heating risers, pipes which are arranged to be




grouped at those points. The flue answers a double purpose, as by its means the risers are kept free of the walls, and the too common fault of bricking-in piping is avoided. The horizontal connections and the traps of bath tubs are arranged in a space between the under side of the floor beams and a false or hanging ceiling, this space being open to the vent flue. Thus any leakage of sewer gas at the joints or traps is drawn off by the vent system.

These various flues pierce the building from the second floor level to the floor of seventeenth, where they connect into galvanized steel ducts, by which they are grouped to five centres, at each of which is a 48″ Seymour disc fan, electrically operated by a direct-connected Lundell motor. The connection of the smoke discharge was made in the manner illustrated as follows:

Under the curved portion of the seventeenth floor outer walls, due to the mansard roof, a system of ducts was extended, planned to run as nearly as possible over the line of all smoke flues. Where interior fireplaces twisted there was provided a separate rising extension to the ceiling of the seventeenth. All there were as before described connected to the fans. In the southwest quarter of the building, a large dining room occupies the sixteenth and seventeenth floors, and here the rising flues of all kinds are connected together by charcoal-iron horizontal ducts covered with air-cell asbestos extended over the ceiling of the fifteenth floor, to one of the vent shafts connecting to a fan. Vitrified earthenware drain pipes were proposed and adopted for the vertical flues and are arranged to stand within the interior spaces occupied by chimney breasts, and passing up alongside the iron fire hearths, occupy no space in the partitions or walls of the rooms. One line of 8″ pipe is provided for a tier of fireplaces, and where two back on to each other, a line for each is provided and alternately connected. Some of the outside flues, where an outside chimney stack occurs, have been provided with a by-pass and cut-off, connecting them to the outside stack. This was done simply as a concession to non-technical prejudice and from no feeling that it was necessary or desirable. In most cases, however, no such connection suits, nor can it be made.

The earthenware pipes are connected by 4″ bends to the fireplaces, by a spigot specially made the reverse direction to ordinary sanitary patterns. The bend is set into a spigot formed on the top of the iron fire-hearth, which was designed specially with a tapered top, contracted to a throat in which a butterfly damper is set at a fixed point by a set screw.

The support of these lines of smoke pipe, each of which is about 186 feet in height, was very simply effected by arranging as a bed for each fireplace a mass of cement concrete with wire rods imbedded therein, forming the floor thickness above the

floor arch-top up to the finished hearth level. This was extended in any convenient direction so as to reach over the nearest floor beams and obtain a thorough support. In this bed, the socket of the vertical drain pipe was set and bedded, and connected to the corresponding pipe rising from the floor below. The weight on any floor is, therefore, only that of the length of pipe corresponding to its height. On the unoccupied side of the interior of the chimney-breast, a hole was opened through the bed and the arch below. This was simply cemented in any convenient shape, in corner fireplaces being triangular.

Around the whole the chimney-breast was built, the iron fire-hearth having been set, and its front arch being made of sufficient strength to carry the centre of the breast.

Most of the fireplaces have been provided with gas-logs, but the system was planned for dealing with the products of combustion from a certain amount of coal or wood fires, and the opening can at any point be set to suit.

The net reduction in cost by this departure from ordinary methods of flue construction was fully $26,000, and had the outside chimneys been dispensed with as much more might have been saved.

One considerable advantage appears to result, namely, that on starting a fire or a gas-log a draft is immediately obtainable. In tall buildings, annoyance is frequently experienced from smoke and gas, due to the cold chimney failing to draw off the products of combustion.

For large buildings it may be expected that this system will eventually displace the use of outside chimney stacks.

## DISCUSSION.

Mr. R. P. Bolton: As the paper is before you I will not take up your time in reading it through, but will briefly describe its contents. This is an effort to place before you a scheme carried out in a large apartment building, the Ansonia, to meet the difficulty of providing gravity chimney-stacks for the very numerous fireplaces throughout the building, a difficulty that confronts architects in nearly all the taller apartment buildings, and one which, so far as I am aware, has not

been met in this way. One great objection that I have found among tenants in apartments, especially in tall apartment houses, is that when they start their gas logs in their parlors or bedrooms the gas works back into the room. This simply means that the flue is so chilled that it will not carry off the gas arising from the gas logs, and it backs into the room. In this case we practically made vents of the chimneys, up which a draught is always available, by fans on the roof. The particular system adopted was modified to suit a steel framing construction, in the manner illustrated on the third page, and we succeeded in very considerably reducing the cost of the flues by using terra-cotta drain-pipes, and connecting an entire range of fire-places, fifteen and sixteen high, to one such drain-pipe. Objection has been raised to the use of such drain-pipes, with cemented connections, from the possibility of their joints cracking and becoming leaky. In this case that objection was overcome by standing them inside of the chimney breasts. Therefore it is immaterial whether the joints should crack or not, but so far as I am aware no such difficulty has been encountered in this building. The system was further adapted to suit the already designed ventilating system of the toilet rooms, which it is thought necessary to describe in connection with it, and also the general system of the ventilation of the building. This consists of a supply of air into each apartment in the private hallway, with exits at the toilet-rooms and kitchens—at each fireplace—and at certain vents in the upper part of each chimney breast. I want to say that the placing of these latter vents in the upper part of the room was not my own idea. It was a fad of the owner, and I think it is not a good position in which to place them. I would have increased the smoke opening of the fireplace and made that a positive vent at all times. The economical results of this scheme were very satisfactory, because in this case, and in all cases where steel-framing is to be encountered by lines of smoke flues, there was an immense amount of detail and complication in getting the flues through. Generally, the architect plans fire-escapes on outer walls, so that flues may run up in or on the faces of the outer walls. In this case they were desired to be placed on the interior partitions, and by the system described that can very readily be

done. And a very considerable advantage results, because the fireplace can be better disposed in the room in that manner than by putting it on the outside walls, which is very precious space. It is very common to see them placed across the corner of the room near the window, which makes an awkward arrangement for the furniture.

I should be very glad to hear if this system has been utilized in any other building. I don't want to claim that it is such a remarkably original system that it needs to be adopted all the world over, but there are places where ventilation already existing can be adapted in this manner, and I think that in New York city a good many architects would find it very useful. I commend it to your consideration.

The President: You have heard the paper which Mr. Bolton has read by abstract, as it were. What will you do with it?

Mr. Kent: Is it the intention to run that fan twenty-four hours a day throughout the year?

Mr. Bolton: Yes, it is practically a day and night service.

Mr. Kent: In case that fan stops there would be communication from the toilet-rooms, and you might have a circulating system from the toilet-room into the sitting-room. I suggest that to prevent that condition the single motor that drives the fan might have two fans on it. These two horizontal flues should have separate outlets, each with its own fan, but the two fans might be on the same shaft so that one motor could drive them. That would make a clear separation of the two ducts.

Mr. C. M. Lyman: I ask if the draught is uniform from the various fireplaces, or was it stronger in some than in others?

Mr. Bolton: That is an excellent idea of Mr. Kent's, to provide separate exits for these two separate lines of discharge; and in this case I would have done it, but the ventilating system had gone so far that it could hardly be done. The system in this case was an adaptation, as was made clear in the paper. I think that were such a system properly laid out in conformity with the general design of the building that would be the proper method. The chimney system might be entirely separated from any toilet connection. With reference to the amount of draught obtainable in the flues I am sorry that I have not any test to present to the Society at the present

time. The building has been somewhat disorganized, and I have been unable to get results from the line of the flues. The idea has been to set the dampers so as to adjust the draught to each fireplace as may be required. And that has been done to some extent through the occupied part of the building. At another meeting of the Society, I will endeavor, if I can, to get the record of the line of these fireplaces, and also I hope to try wood fires in some of them and see the disposition of the smoke. I might say, in connection with this point, that there is one undoubted result already attained: We don't have the least gas working back into the apartment.

Mr. Barron: The great value of this paper, I believe, is its suggestiveness. It shows very able and capable work in this direction. It suggests to my mind a method of ventilating the high building, connecting the drain tile flues to heating stacks in cellar. There is no question but that the high building may be heated for years by direct radiation, and this suggests the evolving of a system of ventilation in connection with it that will be satisfactory. In that way the paper has value beyond its particular technical point. Its value is in its suggestiveness, as I say, to the engineer of a very good way of combining an actual ventilating system in connection with heating for a tall building, with or without a blower. That is a problem that confronts us now more than almost any other problem. I would like Professor Kinealy to talk a little on the paper, and shall be glad if I can have his views on it for record. If the tile pipe could be put in large enough in area and the blower dispensed with, this system suggested by the paper would be ideal.

Professor Kinealy: I have read the paper with a great deal of interest, and of course I appreciate the difficulties of Mr. Bolton's situation. I don't know that the problem could have been handled any differently. He has worked out a very unique scheme and one that answers the purpose, and it seems to me that is all that is desired.

Mr. Bolton: On the question raised by Mr. Barron I would like to say, without taking any special credit to myself for the general deisgn of ventilating and heating the building, that it appears that it is a more desirable system to follow in apartment houses, to give plenty of direct radiation, es-

pecially under the windows, and to provide the tenants with a fixed amount of ventilation with which they cannot tamper, and which enters at the given temperature desired, and then to oblige that air, so introduced into the apartments, to find its exit through the toilet rooms and kitchens. It seems certain that tenants would throw out any system of ventilation that they have the least chance of monkeying with, but this method puts it out of their reach. I placed the inlet supply registers as high up in the corridors as I could possibly place them, against the cornice, and they are not intended to be provided with chains with which they could be shut off. The same in regard to the kitchen vents, which are placed under the hoods of the gas ranges. The gas range is provided with a little flue pipe, which is extended up to and ends at the vent register, so that the gases are drawn right off from this flue and taken up the vent flue. The servant cannot shut the register off. Similarly, in the toilet-rooms we did not provide any handles on the registers. So long as the fan operates and is in order there will be no trouble.

# CIX.

## HEATING BOILER DEVELOPMENT.

BY H. J. BARRON.

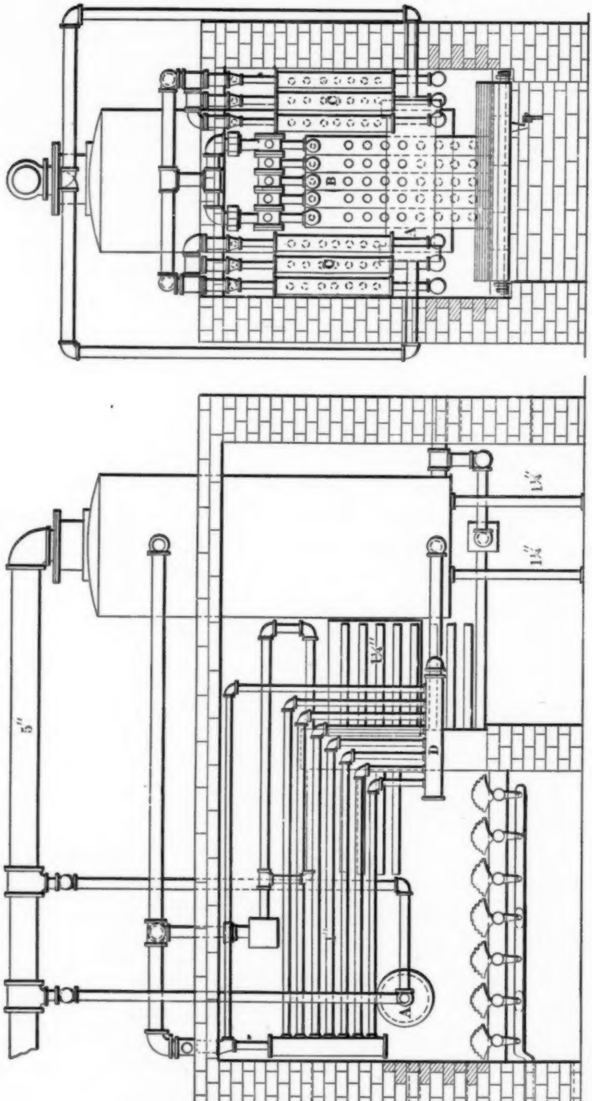
(Member of the Society.)

In the course of my practice I have encountered a frequently recurring combination of special conditions, which impelled me some time ago to design a water-tube boiler to meet such conditions. The principal requirement was that a superheating chamber (A, in the accompanying drawing) should be placed over the fire. The purpose of this chamber, or drum, is to increase the economy in the working of the boiler. Another requirement was that it should be possible to construct the boiler in any ordinary steam-fitter's shop, making it out of regular pipe and fittings.

The boiler is really a combination of the constructions of Blake, Holland and Hopkins. The centre (B) is a five-section Hopkins electric boiler, and on each side are three Blake sections (C), being mitre coils with a mitre resting on the bridge wall and a square, or double-mitre coil making the fire box. There are 35 square feet of heating surface to each square foot of grate area.

The boilers that we have built on this design have not yet been fully tested. Moreover, during their construction we somewhat radically departed from the original design, first in putting in a square double-mitre coil around the fire box, making the boiler internally fired; second, in doing away with the upright tank at the rear and substituting a 7-inch standpipe in place of it.

The original drawing was also departed from in many minor details, as is common in any new construction. For instance, where the drawing shows the manifold projecting into the fire pot, we arranged it so that the face of the manifold (D) was in line with the front of the bridge wall.


5″
D
A
B

I believe the super-heating feature is new in this form. Th main steam pipe from a heating boiler has often been brought down over the fire, and in the cases I have noticed there has always been a decided improvement in the working of the apparatus.

The work I did on this boiler and the possibilities of its usefulness to the trade at large brought to my mind an essay which I prepared some years ago, with the original idea of presenting it at one of the meetings of this Society, embodying certain ideas that I believe govern heating-boiler development, and I will present some of the points in that essay and some later thoughts, hoping that by so doing I may at least lead up to a discussion that shall be not without value.

In my essay I classified heating boilers, as was natural, into the fire-tube and water-tube types; I subdivided these into water-tube externally fired, water-tube internally fired. My consideration of the subject was designed to ascertain, if possible, which of those types would be most valuable from the standpoint of the heating contractor.

I arrived at the conclusion that the internally fired boiler would prevail, because the waste of heat from the casing of the externally fired makes it more wasteful, and that the water-tube would have a preference over the fire-tube. So far as any single type being found acceptable by everybody and for all requirements, I do not imagine that that will ever happen. I presume there will always be about as many varieties as there are now. If we look over the various types of boilers on the market, we can perhaps find some that we think will ultimately disappear from use, but probably something new or some modification of something old will take their places, so that there will still be a variety of patterns of heating boilers.

At present, when one speaks of house-heating boilers, it is generally considered that cast-iron construction is referred to. It has been found that wrought-iron and steel shell-boilers cannot economically be made in very small sizes, and the foundries making that class of boilers in cast iron can afford to sell the larger sizes at lower prices per pound by reason of the increased foundry output and consequent reduction of relative cost. Thus they pretty successfully compete with the less costly steel boilers.

The use of cast iron at once suggests the undesirability of changes, because of the great expense of the patterns and equipment for producing a line of boilers. We can experiment with tubes without serious expense, but an abandoned set of foundry patterns represents a dead loss of considerable magnitude.

Another thing that disposes manufacturers against new departures is their desire to make ratings of boilers of given sizes as nearly uniform as possible. This is to their interest as tending to prevent ill-advised competition in price, and it is for the interest of the heating contractor in that it to some extent insures him against his competitor across the street figuring against him on a particular job with a boiler of equal capacity, purchasable at a lower price.

A new boiler—new in important features—would have to be tested by use before it could be accurately classified as against the older constructions.

Every effort to formulate a rule for accurately rating all boilers by measurement of grate and heating surfaces has been found futile. It is a case where surface is not necessarily surface, nor is grate always grate, nor fire travel, fire travel. It has been sought to classify and appraise the value of different heating surfaces by making crown sheet surface represent 100, and all other surface some fraction of 100; but when we come to indirect or flue surface, the differences are so numerous and the discrepancies so wide that to attempt such a classification would be to undertake a well nigh hopeless task.

Surface backed by water circulating vertically has to be compared with surface where the water circulates laterally, and all the way between are various degrees of inclined circulation.

The products of combustion may strike the surface at right angles or pass alongside of it or impinge against it at any angle —or, as in some cases, not strike it at all.

It may be self-cleaning surface; or it may be the bottom of a flue that is always more or less coated with a non-conducting layer of soot.

There are, in short, so many conditions, almost impossible to calculate, that experience really affords the only reliable standard.

It seems to me that every one must realize that the heating

boiler is becoming so conventionalized that one or two general forms are coming to be regarded as standards; but I sometimes wonder if the manufacturers who control this industry are not proceeding upon lines that tend to check individual initiative or improvement. At all events, I found it impracticable to carry out the ideas indicated in the drawing and description of the special boiler which I designed, and I was moved to institute a comparison between the present day and the time when almost every man connected with the heating business was more or less of a "boiler crank"; that is to say, he was an enthusiast in regard to some one or more special theories of construction which he thought essential to the best results. In order to successfully compete, it seemed necessary that the manufacturer should have the largest number of what are called "talking points," so that he or his salesman could profitably spend time with the steam-fitter and with the house owner, first explaining the principles of operation of a boiler, and then convincing his customer that those principles were more closely followed in his type of boiler than in any other.

This involved a great expenditure of time and money, and the gross profits on boilers were accordingly fixed at a correspondingly high figure. Buyers were willing to pay as much for the selling of a boiler as they paid for the making of it. Now the gross profits are so reduced that the selling expense has been brought down to a point that does not admit of this educational work. Or perhaps, more correctly, the expense of the selling engineer has been saved and is, or can be, added to the profits of the product.

To-day, if a man contemplates the investment of capital in the manufacture of heating boilers, he will probably investigate, first of all, the practical efficiency of the design submitted, then he will carefully calculate the cost of manufacture, and then he will come to the question which, more than any other, changes the conditions of to-day from those of ten years ago—the question of selling expense. If his design departs widely from constructions familiar to all buyers, it seems a campaign of education, which is somewhat more expensive than a political campaign. He may possibly delude himself with the idea that the excellence of the special features in his boiler will be so apparent to every heating engineer and contractor, and to

every house-owner, that it will be only necessary for him to make known the features of his boiler through the usual and comparatively inexpensive modes of publicity. He will find, however, that the majority of steam-fitters will not listen to him; or, if they read his advertisements or his circulars, it will not seem worth their while to enlist themselves in the missionary cause of spreading a new gospel. It is easier for them, when a man orders his building heated, to specify just what is used by the neighbors and friends of the purchaser; that saves the steam-fitter's time, which means his money.

Boiler manufacturers characterize this tendency as an exemplification of the theory of the "survival of the fittest." To the man with original ideas, it seems like an abolition of the opportunity for inventive genius, so that a boiler possessing strikingly new features can only be put upon the market successfully by the backing of enormous capital as compared with what most of the existing companies started with.

The advantages of the present order of things are set forth about as follows: to the house-owner, the certainty that he is going to get something approximately like what he had before or what his neighbors have; to the steam-fitter, no trouble in selecting a boiler adequate to do the work he has on hand, and to the manufacturer, an approach to that millennium when he can sell a boiler as he would sell a keg of nails, without care of to where or how it is to be installed or used, when the steam-fitter will have such data and such knowledge as shall enable him to decide for himself what size of boiler he requires for a given job without relying upon the printed ratings of the manufacturer's catalogue.

The disadvantages are the obstacles thrown in the way of possible improvement, so that development is checked and, to an extent, brought to an absolute standstill.

My aim in this paper has been to get on our records a discussion of the heating-boiler problem, to draw attention to the merits and the drawbacks of the present tendencies of this industry to extreme specialization, and to bring out, if possible, suggestions for the improvement of the boiler and of the particular industry connected with it. Nason, Walworth, Briggs and the early steam-fitters of fifty years ago, not only made their boilers and radiators, but their pipe and fittings; to-day,

the pipe is all made by a trust; the radiators, fittings, etc., are rapidly going the same way; and boilers, obeying the same economic law, must follow. This tendency is resisted to a greater extent abroad than here, the French and German manufacturer installing his own apparatus and controlling the manufacture of every detail. My opinion is that our system will prove ultimately the best in the broadest sense, and is right in the nature of things.

# CX.

## THE CAPACITY OF CAST-IRON SECTIONAL STEAM BOILERS.

BY J. J. BLACKMORE.

(Member of the Society.)

One of the great difficulties of the heating engineer is to determine the relative values of cast iron boilers as offered by the different manufacturers.

One line of boilers will have a very much larger grate area in proportion to its capacity than others, another class will make the grates narrow, and the upper part of the section will extend to a much greater width and consequently will have a larger area of heating surface in proportion to grate area than is the case with a boiler having the section the same width from bottom to top.

Many of the manufacturers give no measurements in their catalogues, of heating surface in boilers of their production, while some do give it, and in cases where it is given the engineer can with some thought select a boiler suitable for his work without relying on the capacity as given in the catalogues of the makers.

There is, however, a difficulty here which, to the engineer, is almost unsurmountable; and that is, how was the surface measured, and has the boiler the heating surface marked for it in the catalogue?

There has long been a desire on the part of the manufacturers to have some standard adopted by which a cast-iron sectional boiler could be rated by any engineer in the same way as a water tube and tubular boilers are rated for power purposes. On the part of the construction engineer, this has been a constant source of uncertainty, as he has been compelled, for want of other information, to rely on the manufacturer's rating of a

boiler, and to make a liberal discount on that to be on the safe side.

The cast-iron sectional boiler has undoubted advantages for heating purposes, over steel constructions, as is evidenced by the rapid increase in their use. This is no doubt due to the small units from which they can be made up, thus making the boiler portable, easy to repair, easy to add to for future increases, and above all, its safety, due to the steam being kept in several compartments of small capacity as against one large steam chamber as in a tubular boiler.

There should be some recognized standard of measurement for all cast-iron sectional boilers, and it should be so simple and equitable that all makers and engineers would mutually adopt it for computing the heating surface. The quantity of surface being computed, then it becomes a simple matter to adopt a ratio of boiler heating surface to the radiation it is to supply.

In the measurement of heating surface in a sectional cast-iron boiler of a vertical type, it is best to consider it as a flat surface having two sides and take the inside surface to fill in the space made in the section to form the fire-box and flues. Various tests have shown that the fairest way to get this is to take the outside width of the flues across the section, the extreme height of the section from the grate line to the top. A question then arises that all sections are not of the same thickness, and to provide for that, the thickness of the section is to be added to the width. Again, it is found that there is a difference in the height of a boiler with a header or steam drum.

If we are to take the measurement of the section only and ignore the drum, the measurement would not be fair to the boilers of the push-nipple type, as the drum on top of the section does in a measure increase the capacity of a boiler by allowing a higher water line to be carried. Careful comparisons have shown that this condition can be met in perfect fairness to both by adding 10 per cent. to the height of section in all header boilers. In the case of the push-nipple type of boiler the rule would be as follows:

$$\frac{(W + D) \times H \times 2}{144} = X$$

In the case of the header type of boiler the rule would be modified as follows:

$$\frac{(W + D) \times (h + H) \times 2}{144} = X$$

In which "W" represents width across flues in inches at water line of heater, "D" represents depth of section in inches, "H" the height in inches from grate line to top of section and "h" 10 per cent. added to height in the case of header boilers; and "X" the result, or measurement in square feet of heating surface per section.

The question of the value of the front and back sections must now be considered. It is quite manifest that the front part of the front section performs no work and the same is nearly so of the back section; this being the case, the surface should be considered as only half for each of the front and back sections. By this deduction we would count the value of one section off each boiler and would figure the surface of a five-section boiler as that contained in four sections and that of a seven-section boiler the surface of a six-section, and so on.

By adopting such a rule as a standard, all sectional cast-iron boilers can be safely measured and their value can be easily determined.

It may be said that such measurement will not accurately determine the value of all the various makes of this type of boiler. This may, in a measure, be correct, but any difference in this respect can be adjusted in settling the ratio of boiler surface to radiating surface in the different boilers. How shall this ratio be established?

To determine the ratio of boiler surface to heating surface it is well to refer to the standards adopted by engineers to determine the value in horse-power of tubular and water-tube boilers.

A horse-power as applied to the capacity of a boiler is equivalent to the evaporation of 34.5 pounds of water per hour from and at 212 degrees, this is equivalent to 33,316 B. T. U. per hour. To compare this we will consider the heat lost by 100 square feet of radiation in a room at 70 degrees with the average temperature. As a foot of steam radiation loses approxi-

mately 275 units of heat per square foot per hour, this would be equal to 27,500 units for 100 square feet of radiation, which would make a rated boiler horse-power as equal to 122 square feet of radiation.

In power-boiler practice, engineers require 10 square feet of heating surface per horse-power for water-tube boilers and 12½ square feet for tubular boilers.

In the case of the water-tube type it is, however, customary to require an actual test that will develop 125 horse-power for each rated 100 horse-power. As the cast-iron sectional type of boiler has a good deal of flue surface, it approximates more nearly the value of a tubular construction than of the water-tube type, and to be on the safe side it is better to rate on the basis of the tubular type, which is approximately equal to one square foot of boiler surface to 10 square feet of radiation.

This, however, must be modified to give a smaller ratio to boilers of small capacity in which the rate of combustion is slow, of one square foot of boiler surface to eight of radiation, and progressively 1 to 9, 1 to 10, 1 to 11 and 1 to 12 for boilers having a larger proportion of direct fire surface.

With a standard for measurement of cast-iron sectional boilers on this basis and a definite ratio for different sizes and constructions established, one of the greatest of the difficulties of the constructing engineer will have disappeared.

## DISCUSSION OF MR. BARRON'S AND MR. BLACKMORE'S PAPERS.

Mr. Thompson: My wish was, more than anything else, to get before this association the idea of a better method of rating boilers, and that you tell the manufacturers what you want. I believe I said that while I have heard a great deal of complaint from heating contractors—I won't say heating engineers any more, but heating contractors, because there are probably more of them than heating engineers—I have heard a great deal of complaint about steam boilers not being rated to suit them. But there is nobody who has ever come forward to explain anything that is troubling him. After all it is a matter of commercialism, and the successful manufacturer who wants to make a good reputation and keep it must be honest with you, and he must give you goods of a fair value.

And I will say that he is just as anxious to give you a line of boilers that will level up to the rating as you are to have him do so. My idea was to take a boiler and have the manufacturer test the boiler for you, and give the boiler's potential based on the coal available and the calorific power available from the charge of fuel. If the boiler has a fuel capacity of 250 pounds, and you reserve 50 pounds for re-coaling, you have only 200 pounds of coal available. If that boiler is run on an eight hour basis and will utilize 9,000 heat units out of each pound of fuel, you multiply 9,000 heat units by 200 and it will give you in British Thermal units the united number of heat units you have available from that charge of fuel. I should not have said eight hours; you may run it in any way you want to. You get so many units out of the fuel. Then the heating contractor has laid before him his boiler's potential in British Thermal units; that he can divide to suit him self, either by eight, or nine or ten hours, providing the boiler is so arranged with flues and attached to flues—I am here always considering the normal conditions—so that it will consume its coal in six hours, or eight hours, or will run for ten hours, as you wish. But suppose you decide to run for eight hours: if he divides by eight hours it will give him his hourly potential. And then if he takes his rate of emission per square foot of radiation at the temperature of 220 degrees with the air at 70 degrees, a radiator of exceptionally high efficiency ought to give 300 heat units. I know they do not all do that, but suppose they do, and you divide by 300 it will give the boiler's capacity. I cannot see where there is any mistake made there. To make that a little clearer I will read what I was going to show you in the way of comparison.

I have a little table here that shows a few boilers of practically the same size. The heating surface varies somewhat, and one of the surprising things about it is that the boiler with the smallest quantity of heating surface is not the boiler which, when levelled up to the proper basis, performed the least work. In my experiments I have taken coal as only containing 12,000 heat units. It is not selected coal. The experiments were not made for the laboratory or by college professors. That is, of course, the proper way when you want to get down to a really scientific basis. My experiments were

made to appeal to the practical man, to the heating contractor, and I took the coal as it came, not selected at all; and some of that coal was not very good coal, but it did not vary very much. The amount of heat absorbed from the coal varied less than you would imagine. Here are six or seven round boilers with a diameter of fire pot of 24 inches. Maybe not all have a 24-inch grate; some were a little larger. One of these boilers, the one showing the highest efficiency, had 68 sq. ft. of heating surface and 3.7 sq. ft. of grate surface. Figuring coal on a basis of 12,000 heat units, and taking the percentage of economical efficiency, that is, the efficiency of the number of heat units utilized from each pound of coal by the boiler, that boiler gave an efficiency of 77.9 per cent. The next boiler had 59.6 sq. ft. of heating surface and 3.14 sq. ft. of grate, and the efficiency was 76.3. The next boiler had 53 sq. ft. of heating surface, and this had an efficiency of 75.9. These three are not very far apart. Now we come to a boiler with only 42 sq. ft. of heating surface and the efficiency drops to 62.2; the next was 43 sq. ft. and there the efficiency was 66.5; the next 52 sq. ft. and the efficiency was 68.9, and the next with a heating surface of 55 sq. ft., had an efficiency of 70.9. Now, here is another thing. This boiler, levelled up to an eight hour basis, and a two-pound basis, that is, with two pounds pressure of steam—because if you are going to compare boilers you must put them all on the same footing—we found that the boiler with 42 sq. ft. of heating surface had a capacity, on the basis on which I figured, of 622 sq. ft. of radiation, and one with 68 sq. ft. of heating surface, 778 sq. ft. of radiation, a little over 100 feet more, while one with 59.6 sq. ft. of heating surface had 572 sq. ft. of radiation. The last one had 43 sq. ft. of heating surface and it gave 499 sq. ft. of radiation. And so it goes on. The idea is that here are a number of boilers of practically the same type, and if I give you your choice I think you will probably take one as quickly as the other, and suppose you had not seen them before at all, you would take the boiler that pleased the eye. But there is something that I did not tell you. This boiler with the low amount of heating surface, that had a low percentage of efficiency, but carried its radiation pretty well up, did so because it had 200 pounds of coal available, while the next boiler, that

dropped to 499 sq. ft., only had 50 pounds. You cannot do your work unless you have the motor power. Then the next question is in using this heater power, what percentage of that coal ought to go to waste in the chimney? We know there has to be some. We have to waste our fuel to heat up the air in the flue to get the difference in two columns of air and get a sharp draft on the grate, and everybody who has had experience in heating has come across this fact. The complaint comes in, we will say, that the boiler is not doing its work. You send a man to investigate. If the fire has been shaken up he finds an incandescent line of fire at the grate line, but above that he finds a dull fire, and he says to the owner that the draft is not good. The owner says: "Why, I have all the draft in the world; look what coal I am burning," and he insists that the draft is good. No, you can't make a man believe that he has a poor draft when he is burning so much coal. It is a fact, and we know the reason; the coal is burning with imperfect combustion.

Now, there is one other little item that I want to speak about. I found in a series of tests extending to a number between 350 and 400, and extending also over three years, that the greatest economy obtainable in low pressure steam boilers was with stacks with a temperature ranging between 300 and 400 degrees. I know it is the unpardonable sin to speak about that in some places. They want a smokepipe that you can lay your hands on at all times. But in a condition of that kind your coal is going to waste. There is one exception, and that is in the case of hot-water heating apparatus, where we have days like to-day, or very much milder days, in the early fall and late spring, when a mere whisper is required in the house. On such days, by shutting off the draft, and passing a draft of air over the top of the coal, you can run that two or three days without replenishing. I have known a fire last from two o'clock on Friday afternoon until three o'clock on Monday morning without looking at it, but there was a really good fire left. If I told you it carried 600 feet of radiation you would not believe it. It was in a warehouse in the winter time, but it did not do much work: it simply kept the water from freezing, but it shows you can maintain a fire a very long time under those conditions. But when a boiler is going to

carry its load and do its work you have to have a comparatively high stack temperature.

There is something else I wanted to say. You will see a good many questions brought up. It will be said: "You can carry that amount, perhaps, but what about your fuel waste?" I found that there was not as much difference as I expected in the coal utilized by the boiler running a very short period, say, six or ten hours. But some boilers show more difference than others. That is what these experiments were for, to find out the most reasonable thing. There are a number of boilers put on the market that have a fire grate and then they put sections on top of that. We tried a boiler with seven sections and this was tested very accurately on a tank of water. By that method you cannot make very much of a mistake, and we found that the remarkable thing was that the boiler with seven sections did very much less work and was very much less economical than the boiler with five sections. In fact it was found that the ideal size was the boiler with five sections. That was with a strong draft, a draft regulated to suit the occasion; we were not limited as to draft. And we did not put on a forced draft nor did we use any surface draft. When we got to the seven sections not only did the economy of the boiler fall off, but the efficiency decreased; that is to say, no matter how you figured it the efficiency was lower than when we took off two sections. Now, if that be so, what would become of that boiler if it was put on an indifferent draft—I mean the boiler with seven sections? In my practical experience in the south coal regions of Illinois, I have had more than once to take a section or two off the boiler. Of course, coal there was not so great an object. The matter there was to heat the house. Why was this necessary? Because it was so retarded by the excessive heating surface placed over the grate and the flues were too small. I think that is about all I have to say.

Mr. Kent: I have a little lecture on the board, but I will first say what I have to say concerning the two papers which have just been read.

In regard to Mr. Blackmore's paper and his formula for calculating the heating surface, I must say that I find a serious objection to that. Suppose we have a flue through a cast iron

boiler two feet in every direction, and we measure one foot in the length of it, that will give us eight square feet of heating surface in that one foot length of the flue. I take another boiler of the same size exactly, and put a lot of vertical flues in it with 3-inch gas space and 2¼-inch water space; figuring up the amount of heating surface in one foot of length, it has 22½ square feet of heating surface as against 8. This boiler could have three times the heating surface in the same outside dimensions as the other. It might not be quite as good, but it would be better than eight square feet. For that reason I don't think Mr. Blackmore's formula will hold.

Mr. Barron says that all attempts to get a formula for heating surface in boilers have been inaccurate, on account of the heating surface not always being heating surface and grate surface not always grate surface, and so on. That is perfectly correct, from his standpoint, and whenever people try to find out the difference between different kinds of heating and grate surfaces, they get into trouble. But in large boilers for power purposes the universal custom is to consider everything heating surface which has water on one side and hot gases on the other, whether vertical or horizontal, or covered with ashes or not. And that has been universal custom for twenty years, and it has worked very well. It is not particularly accurate. It does not distinguish between different kinds of heating surface, but is good enough for practical purposes, and is the result of hundreds of experiments. It shows, too, that we cannot distinguish between boilers of the different types of to-day in regard to the average square feet of heating surface, the average of one boiler being no better than the average of another, with few exceptions; for all the ordinary types of boilers it has not been shown by scientific experiments that one man's boiler is better than another in having a more efficient heating surface. Some men have claimed that they could sell less heating surface for the horse power than other makers because their heating surface was more effective, either from its position or the circulation or some cause; but when that has been subjected to an actual trial the other men's heating surface has been found as good. I think we shall have to adopt the same rule for cast iron boilers and say that all heating surface which has water on one side

and gas on the other is to be measured as heating surface. There may be a restriction made that it shall not be considered heating surface unless there is a sufficient area to let the gases through.

As to Mr. Barron's boiler I am sorry that Mr. Barron has attempted at this late day to invent such a boiler. It has got, probably, all the bad features of three obsolete boilers put together. (Laughter.) It is about twenty years since I was on the warpath against such a boiler as this, and I found numerous examples of boilers being thrown out from lack of durability. This type of boiler would not last. It has the defects of horizontal tubes right in the fire. Another bad feature is that it has cast iron or malleable elbows in the fire. The boiler, even if it is used only for heating purposes, will necessarily have to be fed occasionally with fresh water containing more or less scale, and after a while the scale will form substances which will get into the tubes and elbows, and at that place marked "D" in the diagram, where there seems to be a flange head. Another objection is the vertical water drum surrounded by fire-brick where it cannot be got at. A vertical water drum, or any kind of drum, with wrought iron or steel in a cold part of the boiler, is apt to corrode. Here is a drum put in the worst place possible for external corrosion. Another objection to the boiler would be on the score of economy, that is, structurally, the boiler is badly defective.

Mr. Kent: Now for my little lecture on the method of rating cast iron boilers.

We start with what we have to do. The work to be done may be expressed in six different ways. We may have so many square feet of steam radiating surface to supply, and we take 1,000 as the unit, or we may have 60 per cent. more of hot water surface to supply. The great majority of people say: "We have a building so big—how much of a boiler will it take to heat it?" That is the roughest and crudest method of specifying what the work is that has to be done. But we have to have some rule, and that figure of 48,000 I took from a heater's company's catalogue as the amount of cubic feet space heated by 1,000 square feet of steam radiating surface. The most accurate measure of the work to be done is in British thermal units. You have to make assumptions, of course, as to the

thickness of the walls of the building, the amount of draft surface, the temperature outside and the temperature inside, and all the other things that are usually considered; but if we get these things right the most accurate is the British thermal unit per hour, and I have taken 300,000 as the equivalent to 1,000 square feet of radiating surface; 275,000 would probably be more accurate, but you want to make extra allowance for additional heat. Here, again, I say that 1,000 square feet of steam radiating surface is equivalent to 310.6 pounds of steam from and at 212°. That is dividing this 300,000 by 966 British thermal units to the pound of steam, and you get 310.6; and dividing that by 34.5 it comes to about 9 horse-power. So we have all these different ways of expressing the work to be done.

Then we ask, how much heating surface, how much grate surface, how many pounds of coal per hour, how much chimney and flue area are required, and what is the size of the gas passages? I leave the last two out.

WORK TO BE DONE.

| To supply radiating surface. | | To heat Space | To furnish B. T. U. per hr. | To make Steam, lbs., from and at 212° | To deliver Boiler H. P. |
|---|---|---|---|---|---|
| Steam 1,000 sq. ft. A | Hot Water. 1,600 sq. ft. B | 48,000 cu. ft. C | 300,000 D | 310.6 E | 9 F |

How much heating surface—grate surface—lbs. coal per hour?

How much chimney and flue area—sizes of gas passages?

| Heating surface. | | | Grate surface (H S = 155.3). | | | | |
|---|---|---|---|---|---|---|---|
| At 2 lbs. 155.3 | At 3 lbs. 103.5 | A present construction 149 H | At rates Sq. ft... | 20 7.77 | 25 6.21 G | 30 5.51 | A present constr'on 6.17 |

| Lbs. coal per hour. | | | | Coal per sq. ft. grate per hour. |
|---|---|---|---|---|
| Water..... Coal...... | 9 34.5 | 8 38.8 | 7 44.4 | a = coal ÷ 6 (sq. ft. grate) sq. ft., 5.75, 6.47, 7.40 |

H = 150 = 0.15 A = 0.15 B ÷ 1.6 = D ÷ 2000 = 0.483 E = H. P. × 50 ÷ 3
G = 6.21 A ÷ 160 = H ÷ 24 = 0.2 E = 0.7 H. P. = D ÷ 48,300

Taking the heating surface; in power boilers it is determined by assuming a certain rate of evaporation per square

foot of heating surface. If you want the most economical rate possible say that two pounds of water per square foot of heating surface per hour is the rate of evaporation. If you want to pay a little less for the boiler take three pounds, and that will give you nearly the same economy as two pounds. Two pounds is a safe figure for slow work, allowing a certain amount for emergencies and all that; but the usual practice for power boilers is to allow three pounds of water evaporated per square foot of heating surface per hour, with a maximum of economy as to cost of installation and everything else. The manufacturers say, "We run our boilers at 4½ pounds of water per square foot of heating surface per hour, and get just as good economy as the other." That is true. There have been boilers driven at the rate of 4½ pounds of water per square foot of heating surface per hour with just as good economy as another man's with three pounds. But if you analyze that you will find that the man that got 4½ pounds did not get it on account of the proportion of heating surface, but because he had better combustion, or a better arrangement of fire, or something similar. He overcame the furnace trouble and not the boiler trouble, and that man, if he had more heating surface, would have got still better results.

Taking now these two figures, 2 pounds and 3 pounds, we figure the heating surface of the boiler for this work at 155.3 square feet in the one case and 103.5 in the other, based on this figure for power work. But in the manufacturer's catalogue they give 149 for that condition, so that we may establish, then, as the method of calculating heating surface that we allow 2 pounds of water for each square foot.

Now as to the grate surface. We have all sorts of ways for figuring that in power practice. Thirty or forty years ago when land was cheap and boilers were made with a plain cylinder, it was customary to make boilers with 20 square feet of heating surface to one square foot of grate area. As people began to drive boilers faster they found the chimney temperature was too high and they put on more heating surface, and it got up to 30 square feet. But as real estate got higher in price and it took too much space to put a boiler in, they piled in more boiler surface, and they got the rate up to 40 or 60 square feet of heating surface. In some modern steam boilers

they put 60 square feet of heating surface above one square foot of grate, not to get economy out of the coal but out of the real estate. They could not afford the room to put in a big grate surface. They put in all the heating surface they could well pay for. They had limited room; and they limited the grate surface to one-fortieth or one-fiftieth or one-sixtieth of the amount of heating surface. Where there is no such limit there seems to be no reason why we should not come back to the old figure of from 20 to 30 and say that is a good figure.

How much grate surface will we have, then on these three different assumptions? I find the figures are 7.77, 6.21, 5.51; and the catalogue gives 6.17, which, figuring from 149, is at the ratio of 24 to one. I do not see any reason to doubt that that is a very good figure.

Now as to the pounds of coal burned per hour. We have this definite amount of water to evaporate, and how many pounds of coal it will take depends on the quality of the coal and how well it is burned. Three figures are given, for 9 pounds, 8 pounds, 7 pounds of water, corresponding to 34.5, 38.8, 44.4 pounds of coal burned under these conditions.

Under the head of grate surface take this figure, 6.21, and call it 6 for convenience, divided into the coal burned per hour. and we get three rates of combustion, 5.75, 6.47, and 7.40, approximately 6½ pounds of coal per square foot of grate surface per hour.

These cast iron boilers are all rated for the worst conditions, zero out of doors and 70 degrees inside. It means the most rapid rate at which the boilers can be driven. This brings us to the conclusion that cast iron boilers are not intended to be driven at a rate of over 6½ pounds of coal per square foot of grate surface per hour. This is about one-fourth of the rate at which coal is burned under power boilers. In electric power plants they are using 40 pounds and in locomotive practice the figure runs up to the neighborhood of 200 pounds. But it is advisable in small steam boilers not to fire up too often, in order to save labor and trouble, and 6½ pounds of coal per hour for the maximum conditions and 2 or 3 pounds for the normal condition, and a fraction of a pound in the condition mentioned by Mr. Thompson, where they kept the fire burning two or three days without replenishing—those are all proper rates

for the conditions named; but I don't think it is advisable to raise the rate much above that figure of $6\frac{1}{2}$ pounds, because it means a great amount of trouble, the trouble consequent upon handling coal too frequently.

Now if we give names to all these things, A, B, C, D, etc., we can make up our formula. Take H as 149, and call it 150 for convenience. We have then these equations:

The heating surface (H) is $\frac{15}{100}$ of the steam radiating surface (A), or $\frac{15}{100}$ of the hot water radiating surface (B) divided by 1.6; or it is $\frac{1}{2000}$ part of the heat units per hour (D); or it is $\frac{483}{1000}$ of the amount of steam (E); or $\frac{50}{3}$ of the horse power. That is the way to proportion the heating surface.

Take now this figure for the grate surface, 6.21 (G), and it is $\frac{1}{25}$ of the heating surface (H), or $\frac{2}{10}$ of the amount of steam from and at 212 (E), or $\frac{7}{10}$ of the horse power (H.P.), or the British thermal units (D) divided by 48,300—call it 50,000 as an approximation.

That is the formula I propose for rating cast-iron heating boilers, subject to revision. If any one has a better formula and reasons for it I would like to have it.

I would like to say this, also, for rating cast iron boilers. Take a boiler rated at any certain capacity—call it No. 9, or any boiler with a guaranteed capacity in British thermal units—then it should have this proportion of heating surface, and this proportion of grate surface. (Referring to formula.) And if any boiler has more than this proportion of heating surface, and less than this proportion of grate surface, it shall be rated by the lower figure. A man has to have both grate and heating surface, and if he has to give too much of one and not enough of the other, he should rate the boiler by the figure of the one that is not enough.

Mr. Wolfe: Personally I think that is the most rational and best basis for rating heating boilers I ever knew of, and I ask that it be carefully copied by the stenographer and embodied in the report, inasmuch as there is no printed paper embodying it.

Mr. J. J. Blackmore: I quite agree with all that Mr. Kent has put on the board, but I do not agree with Mr. Kent's criticism of my formula for measurements. Everything that Mr.

Kent has said is all right: it is perfectly sound; but what I am trying to get at is some simple formula to measure up the heating surface. Mr. Kent very properly puts down an extreme condition to show that any formula so based would be wrong: but in the case of a boiler there are certain fixed conditions: there is a definite proportion of flue area to grate area, and a certain portion cut out for the fire box. These conditions you cannot change. Consequently we never get the conditions anything like what Mr. Kent has mentioned. I may demonstrate that a little better by going to the board. There is not very much room here (referring to diagram on the board). Here we have certain definite flues that we must cut out of a boiler. We cannot cut the whole thing out and make it one flue; if we could, I would give in to Mr. Kent at once. Some openings must be cut out for flues and the space for fire box must be cut out also: these are fixed conditions. They are varied by different manufacturers, some making the flues large and some small; but I did as Mr. Kent did, I took a number of boilers which were recognized as having done good work for some years, and I took measures of the surface and saw what they got round those flues, and what they had round the opening cut out of the section for the fire box, and I found, in at least half a dozen cases, that it measured the heating surface exactly by taking this formula. And I concluded that, if that would measure half a dozen of the best kinds of boilers on the market, it was a simple formula that anybody could apply. It is impossible to measure a cast-iron boiler after it has been set up. You would have to take it down, and then there would be a good deal of difference as to the method of measurement, and the heating surface might be measured quite differently by different men. The amount of surface taken out to furnish flues and to form the fire box was nearly 40 per cent. of the surface measurement of the section, and this 40 per cent. practically was absorbed by the surface around the flues alone; hence the reason for taking the extreme height of the section. Why should we take the outside width of the flue in measuring and ignore the surface on the section outside that point. Some method had to be adopted to provide for the difference in the depth of the sections. They vary in the making from 4 to 8½ inches. In one case they were 12 inches. By taking

the depth of the section, and adding it to the width across flues, I accounted for the surface that was left over outside the flues. I don't pretend that it is absolutely accurate, but I contend that it fairly measures all the boilers of good construction on the market, and the adoption of some such formula as this as a standard would lead manufacturers to conform to that formula, and give the best surfaces for the work required. Of course some manufacturers, in their endeavor to get in a large amount of heating surface, will contract the flues, and defeat the object they are trying to obtain. They cannot then maintain the combustion necessary to get the work out of the surface without adequate flue area. Those who make large flues and contract the heating surface suffer in efficiency, because they cannot retain the products of combustion long enough in contact with the surface to get the benefit of the heat they contain.

A Member: Did you take account of the water line on the boiler?

Mr. Blackmore: I did so as far as header boilers were concerned. The 10 per cent. added to their height was because there they carried a higher water line. My paper is devoted to the question of adopting a practical formula for measurements. The difference in the character of the surfaces will then determine the value of the surface. If there is a small quantity of flue surface, and a great deal of fire-box surface, you can put a higher ratio of radiating surface to the boiler surface; so that any inequalities that may exist in the boilers, after the heating surface is measured according to this formula, can be fixed by adjusting the ratio one to eight, one to nine, one to ten, one to eleven, one to twelve, according to the surface. The constructing engineers of the country have knowledge of the value of the heating surface. The great difficulty is to get at the quantity of surface there is in a given boiler. I find that the heating surface listed by manufacturers is not a safe guide. The measurement is there. But in one case I measured, 25 per cent. of the surface given was not efficient, for the reason that it was placed so close together that there was no circulation between the heating surfaces. Yet the surface, according to measurement, was correct.

A Member: As a matter of fact, with push-nipple boilers and

header boilers, is not the water line at least an inch above the flues?

Mr. Blackmore: No. I have made a practical test to determine that point, and in every case where I made the test I found less efficiency where I carried the water above the flues than if it was below, and the efficiency varied in a certain ratio below. It seems to me absolutely necessary to have the water line below the top of the flue.

Mr. Kent: How do you account for that?

Mr. Blackmore: I have tried to account for it in two ways. In a sectional boiler, where we do not carry pressure enough to hold the water down, there is an artificial water line. The water line being set at a point about four inches below the top of flues, the ebullition of the water really maintains an artificial water line above those flues. When the water was carried above the flues the moisture in the steam was 3 per cent. greater than at a point 5 inches below the top of the flues. Of course the efficiency was correspondingly less, and such a boiler was so sensitive that it would prime very easily.

A Member: Was that with the push-nipple or with the header boiler?

Mr. Blackmore: The experiments I am speaking of now were really made with a header boiler, but I have every reason to believe the conditions are the same in both cases. With the header boiler you can carry it closer to the top of the flues. I have experimented with both, but each boiler was with a different section, so I could not get results which could be compared. But one thing was demonstrated in the experiments, namely, that we could carry a little higher water line in the header type than in the push-nipple type.

Mr. L. B. Sherman: I would like to ask Mr. Blackmore a question or two. On the first page of this paper it says: "Many of the manufacturers give no measurements, in their catalogues, of heating surface in boilers of their production, while some do give it, and in cases where it is given, the engineer can with some thought select a boiler suitable for his work without relying on the capacity as given in the catalogues of the makers." It seems to me in the first place we should know definitely what heating surface in the various constructions of boilers is to be counted as heating surface, as we have such a

variety of boilers on the market. What is to be considered as available heating surface in the cast iron boiler such as is usually made? I think, in regard to the majority of boilers on the market, that the man who was estimating for a building using any one of the boilers would have to give a good deal of "thought" to the boiler. I think he would have to take it down and go into a good deal of detail to find out what surface was in the boiler. Some seem to give a large amount of surface. But what is the real amount of effective heating surface to be considered? My idea in raising this question is to urge that it is very important to know what surface should be considered as heating surface and available for effective work.

Mr. Barron: Certain questions have come up in a little different way from what I had intended to treat them. In relation to what Mr. Kent said in criticism of the boiler which I described I have written down a few ideas.

Mr. Barron then read the following paper:

There is no important difference between high and low pressure boilers or between steam and water boilers. The slight modifications required by the particular service does not change the essential attributes except in the mind of the meretricious practitioner; free and unimpeded circulation being the first requirement. The boiler shown is defective in that respect—a vertical water tube is the only form—but having horizontal surface exposed to the fire in a measure compensates for this disadvantage, and with large fire surface in proportion to grate surface and low head room it gives economical working and cheap first cost. The super-heating device overcomes the defect of a tendency to prime; but this type of boiler is very liable to an unsteady water line and will not stand forcing with a quick fire or strong draft, but for ordinary or average slow working it is a good form. This type made of cast iron entirely with slip joints or drive fit joints, with access to every part for frequent cleaning, and with the strength and proportions of the old Harrison or Duplex, would be superior to the best boilers made to-day; but there is not much room for advancement in boiler engineering except in refinement; as any good engineer can design a boiler giving 80 per cent. efficiency and with an economizer 90 per cent. The shell form and the cast sectional, which is practically the same, should be abandoned, and

the engineer should design only the water tube form and confine himself to vertical tubular modifications to meet the particular requirements called for.

Now in those sketches that Mr. Blackmore made, if you draw a circle round that boiler you have a sketch of a return flue boiler, or the Scotch marine boiler, or return tubular boiler. It is a type of boiler that has been evolved in years of work. The boiler I showed in the paper is not a boiler of free circulation. Mr. Babcock put it on record that that form of boiler would never be practical for power purposes. But is it good for certain economical conditions for burning fuel, in my opinion. But this sketch here is a type of vertical boiler. It is a boiler with which I spent 12 years of my life. It is my idea of a vertical boiler in which the circulation is absolutely free. You can force that boiler, and you can put in more heating surface than in the ordinary forms. I have arranged that with an economizer in the sketch. A man designing a heating boiler should arrange it with the economizer feature, and that would allow for an ordinarily good combustion, as has been explained here. My conception is that this shell type of boiler is entirely obsolete, is dying out. (Laughter.) The great advantage of it, however, is that it allows free circulation, And in this form of vertical tubular boiler each tube is really a separate boiler, and gives absolutely free circulation, and in that way a boiler of this type has a great deal of reserve power. From what I have heard I do not think that the boiler question has been properly discussed, but it will come before us again at the next meeting, and the other features can be looked into. My contention is that my solution, The Boiler Trust, will solve the boiler question and the furnace question. These boilers and furnaces will be made in a short time by a trust, which will make standard qualities. And they will solve a great many of the troubles that we have now, that is, such as the heating engineer has in selecting boilers. The heating surface will be given out with authority and the boilers will not cost any more than they cost to-day, but the purchaser will have to pay the price the trust asks for them. This will relieve the heating engineer of a great deal of responsibility in regard to the making of the boiler.

## CXI.

# COOLING AN AUDITORIUM BY THE USE OF ICE.

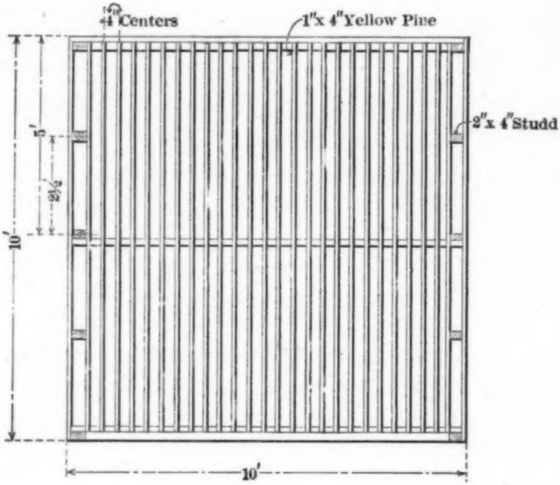
BY JOHN J. HARRIS.

(Member of the Society.)

Two days previous to the commencement exercises in the Scranton High School, June, 1901, the writer was requested by the Board of Directors to devise some means by which the auditorium could be kept at a comfortable temperature during the exercises and not become overheated. Time being short, the only resource left was by the use of ice.

A rack was constructed in the fresh air inlet large enough to hold about 8 tons of ice, with several shelves having slatted bottoms, the frame being made from 2 x 4 inch hemlock studs. At 6 o'clock in the evening the ice was placed in the rack and staggered in such a way that the air was compelled to pass around and between the cakes of ice until discharged by the fan through the flues into the auditorium above, to mingle with the sultry atmosphere; tempering, diffusing and maintaining a temperature that was most invigorating. The bottom or floor of the rack was made from matched pine lumber and lined with No. 28 galvanized iron, and drained by a 2-inch gas pipe. Two fans of the disk type are employed to ventilate this building, one 11 feet diameter, and an 8-foot diameter exhaust fan, located in the attic, the air being forced into the auditorium through a vertical flue at each side of the stage and from above the dressing rooms, foul air making its exit through the registers in the floor, and which are located in the aisles. The construction of this system admits of by-passing all the air intended for the building through the auditorium.

That such an arrangement is necessary can readily be seen from the fact that the seating capacity of this room is 900, but on occasions of this kind about 1,400 persons gain admittance, filling every available space to overflowing. The outside tem-




Plan


Front Elevation

REFRIGERATOR FOR HIGH SCHOOL.

perature was 90 degrees F., while the inside temperature was maintained at 76 degrees F. The humidity was normal, and at no time reached a point of saturation. That it proved satisfactory can best be demonstrated by the fact that the directors were so well pleased that they desire the method to be used for the coming exercises, June, 1902.

The size of the auditorium is 80 feet by 80 feet by 20 feet high. The amount of ice melted was, on June 11, 13,600 pounds; June 12, 11,800 pounds; June 13, 13,000 pounds, making a total of 38,400 pounds melted during the three nights. The fans were designed to deliver 3,000,000 of cubic feet of air per hour under the friction of the ducts; the speed of the plenum fan was 100 revolutions per minute and that of the exhaust fan 120 revolutions per minute. By the use of calcium chloride an absolute control of the moisture was maintained. In the case of rooms cooled by means of ice, or by direct ammonia expansion, or by any refrigerating plant, calcium chloride permits of an easy regulation of the percentage of moisture, as it has a capacity to absorb three times its own weight in the moisture before becoming fully dissolved. The method of applying calcium chloride for this purpose is to dispose the same in shallow pans with perforated false bottoms, so as to allow the accumulated moisture to drain off and deposit in the bottom of the pans, and they should be placed in the ducts where the rapid currents of air pass over the surface of the calcium. The commercial calcium chloride should be practically chemically pure, containing no chloride of sodium or chloride of magnesium, which, with the above purpose in view, are absolutely useless, having comparatively little affinity for moisture.

## DISCUSSION AT THE ATLANTIC CITY MEETING, JUNE, 1902.

Secretary Mackay: Mr. Harris mentioned to me that under exactly similar conditions of outside temperature and on the 14th of this month, there were sixteen hundred in the room and he maintained 72 degrees in an outside temperature of 90, and that as an experiment they added about five per cent. of salt with the ice this year and they found it an advantage, both in lowering the temperature and in reducing the melting of the ice.

The President: Gentlemen, you have heard the paper read and it is before you for discussion. I suppose Mr. Mackay, having had a talk with Mr. Harris, is his sponsor and will answer questions. Can Mr. Kent tell us anything on this subject?

Mr. William Kent: Mr. President, I do not know anything about this subject from actual practice and therefore I am scarcely prepared to talk upon it. I have no preconceptions on the matter from experience, although I have a good deal of theory. This paper is like the little neck clams we get at Atlantic City—a good sample; but there is not enough of it. I suggest that the Secretary write to Mr. Harris and have him expand this paper and put in some more information. He tells how large the fans were, but does not give the velocity of the fans or the size of the room. There are several things that it is necessary to know in order to have a full comprehension of the paper. Another thing is that the humidity was normal and at no point reached the point of saturation. I would like to know what he means by normal humidity. It might have reached 95 per cent., which would have been uncomfortable. I know other attempts have been made to cool with ice and have failed on account of the excessive humidity. It seems that if you carry air that is normally near saturation into a chamber filled with ice, the escaping air will be thoroughly saturated. Then, if you bring that cold air which is thoroughly saturated into a hall which has warm air which is near the saturation point, you will make a fog, a mist, and deposit moisture on the walls. If the original air fed to this apparatus was pretty dry, then he might have got these very successful results; but I think on another day or down nearer the seacoast the thing might have failed altogether. I think we ought to go into this thing a little more, because certainly ice cooling and cooling by refrigerating machinery is going to come; but there is no proper method laid down in the books or transactions that I know of. I hope it will be seen in our Transactions before long.

Secretary Mackay: There are two points in favor of this; one is, that they seem to have accomplished the work to the satisfaction of the school board to such an extent that they ordered it done in the same way the following year, and that this year they have accomplished better results by the applica-

tion of salt, which they had not used the previous year; as to saturation, there seems to be no objection in regard to that; that is, it does not reach a point where there would be an objection. It is a practical application of the cooling of a room, and a room that was intended ordinarily to be occupied by 900 people was occupied by almost double that number, 1,600. Still, with an outside temperature of 90 degrees, it was not unbearable, and there was no necessity for the use of fans with a temperature of 72 degrees inside.

The President: Was it the same school board?

Secretary Mackay: The same school board, yes. A gentleman I was talking to to-day said he had been on the board some eight or ten years.

Mr. Broomell: It seems to me that it is a good deal easier to design an apparatus that will cool a room, than it is to design a school board that will pay the bill. My friends Mr. Wolfe and Mr. Wilson will remember a little experience we had in York with a school board. I am sure *that* school board would not have been willing to pay for eight or ten tons of ice at $5.00 or $6.00 a ton to cool a schoolroom. The great point is to get the school directors who are willing to spend $40 or $50 a night to cool a room. I think they are harder to design than the apparatus.

Mr. Blackmore: Mr. Kent's remarks in regard to the paper are very timely. This is peculiarly a question that ought to be developed by the members of this Society. I think we suffer nearly as much in the summer time from over-heat as we do in the winter time from lack of heat, and the agitation of this subject, I think, is quite pertinent at this time. I quite agree with Mr. Kent that the data given to us are very meagre. If the paper could be referred back and enlarged upon for our next meeting I think it would be a move in the right direction. We should know how many cubic feet of air were handled, what the temperature was outside, and the humidity in the atmosphere outside. We should know then how the air was taken out of the room, and what difference it made to the moisture of the air. I presume these records were not noted by the man who cooled the room. His main object was to cool the room and there he stopped. It would be very interesting to know if the course of the currents were the same when they

were cooling as when they were heating. They naturally would be exactly contrary. There is nothing in this paper to show that there was used any different method of putting air in than when used in heating the building. When the air was cooled in the room the air would naturally fall down. In heating it is the reverse. There are so many points that could be brought up in a paper of this kind that it will have to be more thoroughly digested. If the gentleman who wrote the paper would take the matter up and analyze it and put it in a form for our annual meeting he could do a good work. I think myself that a refrigerating plant could be added in connection with what we call a hot-blast plant at a reasonable cost, which would very much improve the apparatus that we are now introducing.

Mr. Wolfe: As Mr. Broomell has said, a refrigerating plant sufficiently large for a school would be prohibitory because the cost would be fifteen or eighteen thousand dollars. That would settle it in the mind of any school board in the country.

Mr. Kent: The most important field in which this refrigeration would be likely to be applied is in certain wards of hospitals. As in the case of President Garfield's illness before his death you know there was an attempt to cool the room in Elberon, which I believe was somewhat successful, but in designing modern hospitals there ought to be some rooms in the hospital that should be adapted to be cooled in the case of certain patients dangerously ill whose life might be saved by lower temperature. They may have a hundred degrees in the shade, and it is pretty hard on sick people. In some cases their lives may be saved by having a refrigerator room. So it would be well for this Society to look into the question of how they could refrigerate rooms.

Mr. Addams: Keith's Theatre in Philadelphia is constantly cooled by iced air. I am told they use a ton of ice for every performance, that is twice a day, and people speak about it as being a success. I think this is the second season. People go there on hot days and remain comfortable and cool, and have no unpleasant effects from it. The ice probably costs them two to three dollars per ton, which makes the operating expenses reasonably economic.

The President: Is there any gentleman from Philadelphia

here who can give us any information in regard to that fact?

Mr. C. M. Stokes: I do not know how the plant is operated as I have never been in it, but I have been in the auditorium in pretty warm weather. In fact I go there on a hot day to get cooled off. You can look down the floor register and see the ice in there.

Mr. Sardou: I understand that Keith's Theatre is cooled by natural induction. They place a little ice under the floor or beneath the registers and allow natural draft to do the work. The windows above create the only draft that they have there.

Secretary Mackay: The Broadway Theatre in New York has been cooled with ice for ten or twelve years. I had occasion some nine years ago to investigate it in connection with a theatre that was going to be built in Massachusetts, and went through it with a gentleman who was interested in the Massachusetts theatre. The manager and engineer reported that it had proved very satisfactory. They have a blower system for the inlet of air but they have no positive means of outlet, and they merely place the ice in an adjoining chamber to the heater, force the air through it and admit it through the ordinary registers. I have never heard any complaints of it. I have been in the theatre a good many times and found it cool and comfortable when it was very oppressive out-of-doors. But I did not make any record or tests or anything of that sort. But they have continued for some twelve or more years to cool this building with ordinary ice. The chamber that the ice is enclosed in is an ordinary wooden trough with slats. The air is passed in through and around the ice, and the ordinary ducts that are used during the winter months for conveying heated air through the building are used in summer to convey the cooled air to the register, but they have no positive exit for the air. They have the openings around the chandelier in the centre and then the ordinary openings such as doors or windows, but no positive exit in the winter or summer for the ventilation, and that system has been very satisfactory both as to temperature and no complaint on the point of saturation.

The President: Is there anything further to be said? Does Mr. Kent wish to incorporate his suggestion in a motion that

the subject matter be referred back to Mr. Harris for enlargement and for data on the subject?

Mr. Kent: I second the motion. Someone else made it. I second it. (Carried.)

## DISCUSSION AT THE NEW YORK MEETING.

The President: You have heard the paper read. It is before you for discussion.

Mr. Kent: I regret that Mr. Harris is not here to answer questions, and I suggest that the Secretary write to him before the paper is finally published and have him add a few things to it—to show, for instance, the amount of chloride of calsium used, the size of the pans, and the cost of absorbing moisture by chloride of calcium. Also how he is going to secure that the chloride of calcium is pure without having a chemist analyze it. And I suggest, further, that the subject of refrigeration be made a question for discussion for some future meeting. I offer that as a suggestion to the Board of Governors.

The President: Will Mr. Kent prepare his questions and put them in the hands of the Secretary?

Mr. Kent: I will.

Mr. Harris [added since the meeting]: Any student of chemistry can determine the purity of calcium chloride. The commercial product, as turned out by the Solvay Process Company, will be found practically chemically pure. It is shipped in 635-pound iron drums, which are well painted with asphalt varnish, so that it can be stored in any place for present or future use.

The trays were made from galvanized iron, nailed to wooden bottoms. A false bottom was placed in each tray, allowing a space of one inch between them for the accumulated moisture to drain off. The size of the trays is 6 inches high, 18 inches wide, and 4 feet long. They were placed in the duct upon ordinary carpenter's scaffolds. The quantity of calcium chloride, as well as the number of trays, should be determined by the volume of air and the required humidity. A whirling psychrometer was used in this case for that purpose. The trays containing the calcium chloride were placed in the duct, one at a time, until the desired result was obtained.

Calculation for cooling the auditorium was made as follows, and may be of interest for comparison, etc. Space to be cooled equalled 128,000 cubic feet; air of the room to be changed every 10 minutes, or 128,000 divided by 10, equals 12,800 cubic feet per minute; air entering the ice rack at 90 degrees Fahrenheit, and the room to be cooled to 70 degrees, or a drop of 20 degrees. Density of air at 90 degrees equals .072, hence the weight of the air equals $12{,}000 \times .072 \times 60 =$ 55,296 pounds of air per hour.

The specific heat of air at constant pressure equals .2375, hence to cool the air 20 degrees will require the abstraction of 55,296 x 20 x .2375 equals 262,656 B. T. U.per hour; heat given out by 1,400 persons equals 560,000 themal units per hour; heat given out by 123 incandescent electric (16 c. p.) lights equals 196,800 thermal units per hour, hence 262,656 plus 560,000 plus 196,800 equals 1,019,456 B. T. U. per hour.

The latent heat of ice is 142.2, hence it will require $\frac{1{,}019{,}456}{142.2 + 38^*}$ or 5657.359 pounds of ice per hour. As the apparatus was used three hours each night, the total amount melted would equal 16,972.077 pounds.

* Temperature of the resulting water from 32 degrees to 70 degrees equals 38 B. T. U. to be added to 142.2.

# CXII.

## TOPICAL DISCUSSIONS.

### TOPIC NO 1.

**"In the manufacture of radiator nipples should steel, wrought iron, or malleable iron be used to insure the greatest durability?" What is to be said on that subject?**

Mr. Dean: If there is no objection, I would like to have added to that list cast iron, the radiators themselves being made of cast iron.

Professor Carpenter: Our experience with radiators in Cornell University, where they have been put together either of steel or wrought iron, has indicated that those materials were not suited for such uses. They give out very quickly. Very frequently you find them with holes in them and quite recently our superintendent of heating has had to take a great number of radiators apart and change the nipples, although they have only been in use a very few years. Our superintendent of heating, Mr. W. C. Dean, who is a member of our Society, suggested in connection with this topic that he believed that copper might prove a very suitable material for this purpose. I myself have some doubts of its being durable in this position, because I think we might possibly have a galvanic couple set up which would produce electrolysis, but otherwise it might be a good material to use. It is certain that steel or wrought iron is very poor material to connect the sections of the radiators with.

Mr. Sherman: I would like to ask the Professor whether those nipples that were taken out were steel or wrought iron?

Professor Carpenter: In some instances they seemed to have been steel and in some instances wrought iron, usually wrought iron. I think we have very few radiators in which steel was used, but in both cases the metal seemed to have failed.

Mr. Kent: I would like to ask Professor Carpenter if the corrosion was in the threads of the nipple or in the body of the nipple itself, and if in the body of the nipple, why should the nipple deteriorate any faster than the pipe to which it was connected?

Professor Carpenter: The corrosion has generally been from the inside and in the form of quite minute holes which worked their way downward or on the inside upward, usually occurring on the lower portion of the nipple, I think almost all in the lower portion of the nipple. We have had some pin-holing effects in some of the pipes in the buildings. It has taken place to quite an extent in some of the buildings, and in my opinion it is due to the same cause, viz.: the action of the very pure water which is found in them on the wrought iron which composes the nipple.

Mr. Sherman: How long have those radiators been in use?

Professor Carpenter: Last winter and the winter before a good many radiators went out in the Law building; that building was built, I think, in 1896 and has been in use ever since. That would be about five years. We have also had it occur in some of the older buildings, but it gave particular trouble in that one building.

Mr. Jellett: That might be produced by two causes. The first is that there is always some little water in the opening in the base of a radiator. It is never at the bottom of the casting. All metal of this kind deteriorates very much more quickly under the action of hot water than it does with steam. Then again the nipples are purposely made quite thin in order to be easily put in place and the sections renewed. I think the principal cause is the same that we have all found in underground return pipes due to the action of the hot water on the metal. I think the same cause holds good in the radiator.

The President: Can Mr. James Mackay of Chicago give us any light on the subject?

Mr. James Mackay: We, in common with other radiator manufacturers, have used a pressed steel nipple, but unfortunately it was light weight. Those nipples deteriorate in from 4 to 7 years to such an extent that a radiator assembled with them will fall to pieces.

We are now using a very much heavier nipple made from seamless drawn tubing which we believe will be durable. I have, however, seen extra heavy steel and wrought iron pipe used for connecting radiators, placed in some cases between the valve and radiator, and sometimes between the valve and risers. These are usually short nipples placed where a small pocket was formed. I have seen these nipples cut out as though chased out on a planer to such an extent that they leaked. This I attribute to the action of condensed water.

The same thing applies to an extra heavy right and left screwed nipple, used on radiators. I have seen many such nipples cut through by the action of condensed water.

Latterly we have been using malleable iron nipples, and I believe such nipples the best, because they will not deteriorate from the action of the water. They possess flexibility, and there is no reason why they should deteriorate. I know of some malleable iron nipples used in this way for twelve years and which are apparently as good now as when installed.

Mr. Dean: I would like to ask if the casting of the radiator deteriorates with the nipple?

Mr. Mackay: The casting is as good as it ever was.

Mr. Dean: Don't you think cast-iron nipples would be all right?

Mr. Mackay: While with something like copper, malleable iron or wrought iron there is a certain amount of elasticity, there is no flexibility to cast iron. It breaks easily. While cast iron has been used, it has been found to break the loops in assembling radiators. So far as resistance to corrosion alone is concerned, there can be no fault to find with cast-iron nipples.

Professor Kinealy: I had occasion two or three years ago to look up the question of the life of steel and wrought iron subjected to the action of pure water and I looked into this question and I found that experiments had been made to determine the life of steel and wrought iron when subjected to distilled water, and it seems that wrought iron, pure wrought iron, will last longer. The purer the iron, the longer it will last. A small amount of carbon shortens the life until you approach the condition of cast iron. What that amount of carbon is, what the percentage of carbon is that must be in this pure wrought iron before the action of distilled water ceases to be-

come excessive, I do not know, and I was unable at the time to find any experiments that would give me that information. I was hunting for a sheathing for steamboats to be used in the Mississippi River that would not deteriorate when exposed to the Mississippi water, and that led to finding what I say I did find.

### TOPIC NO 2.

**"In proportioning boilers for heating purposes, should the boiler be proportioned to the building to be heated or to the radiation provided?"**

Mr. Kent: Mr. President, I should say that the thing to be done is to heat the building, and the boiler should furnish as much heat as the building itself will radiate. There should be enough radiating surface provided to deliver that amount of heat into the rooms. The boiler should be proportioned to the building, but of course the radiating surface should be also proportioned to the building and both should be proportioned to each other. But as there is a good deal of guesswork about the amount of radiation put in a building, different people having different ideas, the thing to do is to proportion the boiler the amount of heat to be generated, and that is determined by the building and by its exposure.

Mr. Rockwood: The proportioning of the furnace to the building is a problem which involves some other conditions besides question of how much heat is to be evolved in the furnace, as every one knows. In the first place we have the deep-rooted and ineradicable belief on the part of the householder that when you "force" the fire, you are wasting coal. When he can see a fire that is only partly alight, which is in the act of making gas as in a gas retort so that you can see a blue flame flickering on the top of the anthracite coal, with the upper door opened and the lower door shut, he feels that he is saving coal; and I find you cannot shake him in that view, no matter what you say or what you do. You are either "too scientific" for him or else you are "against common sense." Of course it is very obvious from the scientific point of view and the point of view of fact, that the highest economy comes with the highest fire-box temperature; but in practice you will run against the snag that with a small area of grate surface and a hot fire it

takes all a man's time to keep the fire going. That is, if you want to maintain a high fire-box temperature you have got to have a relatively small grate and have the fireman put in a little coal often. He will have to spend his entire time at the mouth of the furnace on a cold day, and perhaps the coal saved by economical combustion is worth less than the extra time required of the fireman. It is often the case that the janitor of a building works nights and takes care of the fire in the day-time. I have no doubt it is the general experience that this is the question—the length of the intervals of time between firing—which decides how big the fire-box shall be. I am called as an expert witness in a case now. There is a row on between the owner of an apartment house and the steam heating contractor. The owner of the apartment house says that the furnace is not large enough, because it takes his man all his time going to the fire to put coal on it, and secondly, because he has to force the fire. Undoubtedly he is right in the first and wrong in the second contention, and I am trying to do the contractor justice and yet settle in my own mind how long an interval of time is reasonable between the appearances of the fireman on his job. He has to go now about eight times in ten or twelve hours in zero weather. Is that reasonable? On the other hand, it is economy. There is no question but that the heater will make steam with a fairly cold house, starting in with all the radiators barely warm, as was the case when they made the test the other day. His contention is that the heater is big enough. The householder's contention is that it is not reasonable to require the man to go so often to the furnace. So that, as I have said, the question of how big a fire should be is a practical question to be determined on the consideration of how long a time between firings should be allowed to intervene.

Mr. Kent: I would like to ask Mr. Rockwood to discuss the subject here in the paper whether the boiler should be proportioned to the building or to the heating surface.

Mr. Rockwood: I am trying to talk about that. If it is proportioned to the building there are some considerations to come in besides that.

Mr. Harvey: I would like to ask Mr. Rockwood if he knows the proportion of the boiler to the amount of radiation he has got to supply?

Mr. Rockwood: I do not recall now. It was about two months ago. I have never seen the thing before or since. While I knew it then, I have forgotten it now. My recollection is that we took the catalogue of manufacturers of heating apparatus, of which there are two or three. (Laughter.) We took their own word for how much heating surface should be reasonably allowed for a heater of the size used in this apartment house and in the case described the heater is about 25 or 30 per cent. too small—according to those catalogue figures. (Laughter.) Nevertheless, the heater will do the work if the fire is hot enough.

Mr. Harvey: I should call that about 50 off.

Mr. Kent: I think Mr. Rockwood is on the wrong side of the question. If he had only been retained by the other man—(Laughter).

Mr. Sherman: This topic seeks to ascertain whether the boiler should be proportioned to the building or to the radiation in the building, and it seems to me that there have been a great many errors made in proportioning boilers to radiation, and I would like to know from the experience of some of the members if they have had the same experience where they have proportioned the boilers to the building.

Mr. Harvey: Mr. President, there was a case that I was interested in once, in running a steamboat, which illustrates, perhaps, better than could be done in any other way that I know of, the difference in the economy in forcing a boiler and running it at its natural and its best point of economy. I could take a steamboat that would run ten miles an hour. I could force that boat to 12 miles an hour. It cost about as much more power to run the other two miles of the 12 as it did the first 10 miles. Now that will give you some idea of what the actual results were in the quantity of steam consumed in having to make that much more steam in the same time, and of course the steam was all being used up in the extra revolutions of the engines, and I have found in heating buildings pretty near the same results in regard to heating boilers.

Mr. Jellett: Mr. President, it seems there is another side to this that has not been touched on. I don't know who suggested the question, but between the two sides of the question I should take the side that the boiler should be propor-

tioned to the building. Assume that there is insufficient heating surface in the building, the rate of condensation is much more rapid. Assume that the radiators and coils in that building are in a bath of air which has a uniform temperature of 70 degrees, the rate of condensation per square foot is one thing. If the surrounding air is say not more than 55 degrees, the rate of condensation is much greater, and if you proportion the boiler under those conditions to the square feet of heating surface in the building then your boiler is too small for the work. If you proportion the boiler to the building itself and there is insufficient radiating surface, it is a matter of adding sufficient surface to improve the conditions; or, in the other case, it means to tear out the entire system. I think the members ought to keep that clearly in mind—the effect on the radiation of placing it in a room of 70 and in one of 50 or 55. There are very different results to be obtained from surrounding the radiators with a bath of air 15 or 20 degrees lower than is commonly used.

Mr. Sherman: I had a little experience in connection with a boiler that was sold and put in by a heating engineer of limited experience, although he was well associated and should have had a good training. The boiler was a 1,200 foot boiler, so rated. He put in the building about a thousand feet of coil and about 200 feet radiation and thought the boiler ought to do its work. I asked him what he would do if he had put in all radiation, what quantity of radiation? He said naturally he would put in about 1,500 or 1,600 feet. I said, "Would you expect the boiler to do the work?" He said he would. But it did not, and they put one in later, a boiler rated at about 1,800.

Mr. Vrooman: It appears to me to be a catch question. In the first place you are asked to supply a boiler to heat a build- and in the second place you have a certain amount of radiation supplied. Now, then, all the heating contractor has to do is to supply a boiler that is sufficient to heat that building and if the amount of radiation is not sufficient then he has another contract on his hands.

Mr. James Mackay: I know of a case where a manufacturer sold a boiler which was specified by a firm of architects who had proportioned and specified the amount of radiation for

the building. They specified 1,200 sq. ft. The heating contractor purchased from said manufacturer a boiler with a capacity of about 25 per cent. greater than the number of square feet of radiation specified.

The apparatus failed to heat the building, and the heating contractor immediately made the claim that the boiler was too small. The manufacturer looked the matter up and ascertained that the building required at least 2,200 sq. ft. of radiation. The contractor ordered another boiler of the same capacity and installed it alongside the original boiler, without increasing the amount of radiation in the building.

The contractor claimed the boiler originally sold was too small to do the work and was overrated by the manufacturer, using as an argument the fact that the two boilers with the 1,200 ft. of radiation were now heating the building. This demonstrated to the satisfaction of the contractor that the boilers were overrated and for that reason he refused to pay for the second boiler. The manufacturer simply submitted to an injustice.

This, in my mind, is a case where, through an error in judgment on the part of the architects specifying the radiation, the quantity used was too small for the exposures and is a case where the boiler should be proportioned to the building and not to the radiation. If the radiation had been intelligently proportioned, it would have been perfectly safe to proportion the boiler according to the radiation.

The whole question is one involving incompetent specifications. If original specifications are prepared by engineers who understand their business, question as to whether the boiler should be proportioned to the radiation or to the building would be entirely eliminated. The plan of rating boilers to a given amount of radiation is based upon the proviso that sufficient radiation for the exposures be used and if this is done, no trouble can ensue; but, if through incompetency too small an amount of radiation is employed, the same incompetency would, if proportioning the boiler to the building, make the same error.

It is just as difficult to rate a boiler to take care of a given exposure as it is to take care of a given amount of radiation.

Exposures vary with different buildings just as much as radiation varies.

Professor Carpenter: I have studied this question some little time and I believe I now understand why the question is asked. In nearly all the boiler catalogues the boilers are rated not in reference to the size of building it will heat, but in terms of the radiation it will supply. Now I think the man who put this question wished us to condemn that practice, and if he did, he has certainly been successful.

Secretary Mackay: I would like to relate one or two experiences coming under my notice. One was a concern of manufacturers in this city who manufactured both steam and hot-water boilers. The demand for the hot-water system was large, but the objection was that it took more radiation than steam, and the objection in the minds of these manufacturers was that the large radiators interfere with the instalation of the plant. They concluded they would advocate a scheme of placing hot-water radiation of steam sizes in buildings, place a boiler in connection with this radiation, and put it under pressure and so attain a higher temperature. But the mistake they made was this: in a building that would require 500 feet of steam radiation or 750 feet of water radiation, they put in 500 feet of water radiation and ordinarily would require a 750 foot net-rated water boiler to be of actual capacity if they had sufficient radiation. But they put in a 500 foot boiler, a safety valve on the expansion tank and expected to get pressure. They got pressure, but did not get temperature. The result was that the boiler which was proportioned to the radiation in the building did not heat the building and they actually required a boiler that would carry 1,000 square feet of hot-water radiation before desired results were obtained.

I knew of another case where the manufacturer of a boiler placed one in his building with four square feet of grate area and 800 square feet of hot-water radiation. The boiler proved economical and efficient, but as a means of advertising he placed 100 square feet of radiation on the sidewalk outside of his building. He connected the heater to it with a two-inch flow and return main, and he found that his boiler which was large enough to heat his building requiring 800 feet of radiation would not supply 100 square feet of radiation out on the side-

walk. So it makes a difference how much radiation you place in a room in proportion to its size and exposure as to what size of boiler is required. Some manufacturers say that a 500 foot boiler will heat 500 square feet of radiation whether you put this radiation in a room 10 feet square or in a 10 acre lot. It won't do it, and my opinion is that the boiler should be proportioned to the building regardless of whether the radiation was properly proportioned or not.

Mr. Barron: Mr. President, this is an extremely interesting question, but I am afraid it is getting commonplace. The thing that interested me was Mr. Rockwood's remark about the high combustion in the furnace, and Mr. Harvey's remarks about having reserve capacity and the difficulties you meet with when you are forced to explain the chemistry of combustion to donkeys. There is where you meet the practical conditions that surround a question of this kind. You have got to proportion everything right. You have got to have your heating surface, boiler and chimney right.

My friend Connolly says the whole subject has got to be based on the judgment of the engineer and that the proportions are all stereotyped in the text-books. But I am particularly interested because Mr. Harvey takes an antagonistic attitude to Mr. Rockwood's statement that when you put in a boiler a little small and you force that boiler, according to Mr. Harvey's statement, you do not get as good economy as when you put in a boiler twice the size and run to a slow fire. That, I think, would give the general public the suspicion that their common sense is better than your talent and skill. You take an ordinary layman who does not know a thing about engineering and he will lay down that your fire is all right and the draft is all right—when you know the fire pot is a gas retort and too slow; when you have designed a boiler on an economical basis you must have quick combustion. I know some of the gentlemen think you want to put in as cheap a boiler as you can. That may influence you also. But you can also put in a boiler too large. I am sure Mr. Harvey will get up and tell me a boiler cannot be too large. That is a conception we ought to get rid of. A man can put in radiators too large or pipes too large, and there is no question but that in all our proportions most of us put in everything too large, which is not good engi-

neering. The man that tries to put in things right and gets them too small; the other man of large ideas says it is too cheap, the boiler ought to be larger, the radiation ought to be twice as much. That is the conception we ought to get rid of. Buildings vary. One building will require twice as much radiating surface and twice as large a boiler as another. But I mean talking on general principles, that the contention of the ordinary person you meet outside is that the fires should require almost no attention, and if they have slow combustion, it is economy. The engineer knows that the highest economy is when your fire is bright and when you are almost forcing the fire. That is the way to burn fuel and not make a gas retort of your furnace.

Mr. Harvey: I always like to agree with Mr. Barron. (Laughter.) In the first place, while I made that statement about the great consumption with the extra two miles, I did not tell you that the smokestack was pretty near red-hot. And a large percentage of the heat was going up the chimney instead of being utilized, because the capacity of the boiler could only absorb so much heat, The balance of the heat had to get away, and that was how we were enabled to get that extra steam by just keeping the largest amount going up the chimney. So that is exactly the case as has been stated when you have a boiler that you have to fire eight times in ten hours—I think that was the statement of Mr. Rockwood. If you have to do that there is certainly a tremendous lot of heat going away without giving any results.

Professor Carpenter: It seems to me, Mr. Harvey has made his point very clear. But in the discussion I think it is quite evident that both Mr. Rockwood and Mr. Harvey were right. In order to get perfect combustion we want the highest possible temperature. In order to get complete absorption of the heat we want the lowest possible temperature in the stack. Those two things are quite antagonistic sometimes, and it is necessary in order to secure the best economy to have perfect combustion, and also a very large proportion of the heat absorbed. If we secure one at the expense of the other we get poor results. This, of course, requires good proportions.

Mr. Rockwood: I do not want to be tedious, but I recall to my mind a practical illustration of the point which I made in what Mr. Kent called my irrelevant talk. There was a plant

in the Worcester City Hospital consisting of five return tubular boilers, 60 inches by 14 feet each. There was no indirect radiation in the hospital anywhere. The fires carried under those boilers were of the class that I described. The fire doors were open most of the time and the ash pit doors were closed most of the time, and there was this pale blue flame visible nearly all the time. The janitor could do a great many things besides supply coal. I came along and put in a central boiler plant with only two boilers in it, although we had a large new building to heat in addition to the work required of the five old boilers. We put in entirely indirect fan radiation and ventilation throughout that hospital. The hospital never had been heated under the old régime higher than 60 degrees with the thermometer at zero outside. It now has not been lower than 68 to 70 in zero weather. The fact I wanted to bring out is that the coal consumption with the new arrangement is substantially what it was with the old arrangement as nearly as would be possible. I only use one boiler most of the time. They have another boiler which they can use in severe weather. The fires are white-hot inside those furnaces. There is an economizer to heat water that is used in addition. They do nearly three times as much heating in that hospital as they did before and they don't burn any more coal. They want to know why it is. The scientific reason is that we now make carbon dioxide instead of carbon monoxide in these fires. We burn our gas after we make it in the furnace. When you have a dull fire you simply manufacture a combustible gas.

## TOPIC NO. 3.

**"Are there advantages in the use of hot-air furnaces with fans and motors for heating churches, public halls and similar large buildings not used continuously, from the freedom from freezing, the positive distribution of air, better ventilation and simplicity of management, and if there are, what types of fans, motors and furnaces are best adapted for the work?"**

NO DISCUSSION.

## TOPIC NO. 4.

**"To what extent shomld the advanced and successful engineer place his knowledge and experience at the disposal of those who might need it?"**

Mr. Barron: I had written out a little discussion on that topic, but I cannot find it. The substance of it was that it is

the duty of every engineer—not only a duty to mankind at the present time, but to mankind in the future—to place his knowledge at their disposal. What will be thought of the man a hundred years from now who withholds information in his possession? In a little while we will all be dead. The ablest men in the world at all times have been men who were only too anxious to give away everything they knew. A man by giving gains a great deal more than he gives. I think the highest type of engineers throughout the whole world have always been men ready to give to mankind everything they knew, everything they learned from their experience; and to put it on record for the benefit of those who were to follow them. The finest illustration of that spirit among scientific men to-day is perhaps Professor Lorenz. There is a man who has wonderful skill and scientific ability, and who puts it at the disposal of all mankind. It is a beautiful illustration of the advanced ethics of the medical profession And the standard is just as high, or should be, among engineers. I cannot for the life of me see how any one can conceive the idea of withholding information of any kind. There are commercial reasons in commercial transactions due to our competitive state of civilization, but that state is passing away. And in regard to a number of the problems that we were discussing last night at the dinner we may believe that the coming time will solve them. The men of the future will laugh at the conception of such a question as this being offered to a technical society, that any man should withhold anything he knows from his fellows. The best illustration that I think Americans have of this liberal spirit is found in the essays of Ralph Waldo Emerson, who insisted on the necessity of every man to say what he thinks. No matter what the result may be, if he honestly thinks it to be true at the time, he should publish it,.

Mr. Bolton: There are two ways, I suppose, of regarding this question, and the crux of the matter is at the end of it: It is rather difficult to find out who does need this information and experience. Most of us are accustomed, as we meet a friend, to be asked, "What do you know?" But if you let out all you know then you are apt to lose a good deal of time and gain a good deal of experience in sidewalks. But from a practical point of view the consulting engineer is very

often rather hard put to it to know what he shall do, when those who most need his experience and knowledge come to him and desire to get it, but do not desire to pay for it. It is a little hard to withhold any information that you are very willing to give out, and yet when you see your bread and butter depending on it the secondary consideration comes in with considerable weight. All that, of course, is simply the selfish way of looking at the matter.

Mr. Kent: The man who most needs it is the rich client, who is perfectly able to pay for it. And there are a lot of such men trying to get information out of engineers which the latter have spent years in obtaining, and they try to get it for nothing. I have had men deliberately trying to get information out of me which they ought to pay for. In regard to giving away information, if I was in trouble I would go to Mr. Bolton and ask him without any hesitation, "What would you do with it?" And would he do the same with me. But a rich client comes along and he is in trouble and wants information, and he has plenty of money to pay for it. And I do not think he has any business to expect the consulting engineer to give information for nothing, any more than Mr. Armour of Chicago had any right to expect that Dr. Lorenz should come from Vienna to operate on his daughter for no fee at all. But then Dr. Lorenz gave his information about his method of treatment to the world. Those things are exactly right—that he should give his services for a big fee to one man, and the same services free to the world where there is no such ability to pay.

Mr. Bolton: I had not quite finished: That is a difficulty which one is often confronted with and one modern invention has contributed largely to it, and that is the telephone. Our friends the architects are very much given to the use of the telephone, and it is very hard not to answer when you are asked a plain question. I was going to say that I think that among brethren of the same profession we already practise the same ethics as the medical profession, and are willing to give and receive information. I have always made it my special pleasure, when meeting other engineers, to tell them all I know about what I have learned, and I have had the pleasure of receiving information in return from them. I think, there-

fore, the answer to this question in the form that I have raised, as to who most needs it, would be, that the advanced and successful engineer might properly place his knowledge and experience at the disposal of others of his own kind.

Mr. Kent: I want to make a special illustration of a particular case. I have given to the world freely all I know concerning combustion and fuel, and I have written it in papers for the last twenty years, in transactions of societies, and have written it in a book; and I am free to tell you everything I know about fuel and combustion and heat units. But when a man comes to my office and says: "I want your information upon a certain new process of combustion; what do you charge for it?" I put my figure at such a high price that he is not apt to pay it. I know he wants the information for commercial reasons. One time I gave a man information and charged him a hundred dollars for it, and he handed me the check and said to me: "I am glad to pay you for it. I would rather pay that one hundred dollars than put ten thousand dollars into this invention." I said to him: "My information could be expressed in a few words—the thing is a swindle and a humbug. Shall I give you a written opinion?" "Oh, no," he said. That opinion was formed after an hour and a half of work that day, but it had required years of study and the knowledge of the complete theory of the subject in order to be able to form it. And he was perfectly willing to pay one hundred dollars for it, but I have not found any one willing to pay so much since. I told the man that would be my charge, but that if I had to make a test it would be $250, plus all the expenses, and the expenses of the chemist's investigation; that that would be a pretty high price for the whole thing, but that he had better pay that than spend ten or twenty thousand dollars in experiments for himself. At the same time these opinions, for which we ask high prices, are free to our professional brethren.

Mr. Broomell: We often have requests made to us that we submit plans, specifications and price in competition with others, and these are then thrown, like pearls before swine, before men who really do not know much about the things, and the price is a very large factor in the ultimate decision. There may be some points in these plans that we submit which will be taken out and added to the plans of a cheaper man, and

there the engineer is, of course, expending his time and his efforts, and throwing his skill and knowledge away. That is a point which might be taken up this discussion.

Mr. Quay: I agree heartily with what Mr. Bolton has said, and I am very pleased to find so many of our members willing to prepare papers on practical questions. They deserve the good will of the society. There is another question, however, which I referred to last night at the dinner. It seems to me that our society has gone far enough now to be ready to decide on what engineering work is worth. A man who prepares himself to do engineering business, pays his office rent and other expenses, is entitled to recompense for his work the same as any one else. I do not know whether there has been a committee appointed, or whether this matter has come up before the Society with the view of having any definite price established. If not, it seems to me that it is time we should at least appoint a committee to decide what prices should be charged for engineering work, similar to what the American Institute of Architects has done, and let us publish to the world that we believe that our services are worth so much money. I do not favor the idea of charging one man a greater price than another. I like the *one price* system. It seems to me that there ought to be a committee of three appointed to take up this question and be ready at our next meeting to report a price to be adopted by the Society as the price for engineering work.

The President: Mr. Quay, I understand there is a committee in existence at the present time who are in conference with the American Institute of Architects, Mr. Jellett being chairman, and that he made a partial report last year along those lines.

Mr. Barron: I have found the memorandum that I made, but I will not read it. It is based on that little incident that occurred at the battle of Trafalgar, when Nelson was asked what he should signal to the fleet, and he signaled "England expects every man to do his duty." And I may add to that, "The duty man owes to the social organism is to discuss freely the art that occupies his attention." I wish our men would say what they think. No matter whether it is right or wrong it creates discussion, and if there is error in it, it will be corrected in time. And if every man, even if he is an obscure nobody

like myself, would only say what he thinks, it would be of the greatest help to those of us who sometimes say even what they do not think.

### TOPIC NO 5.

**"Should the heating engineer be expected to provide reserve power in the heating boiler after proper allowance is made for radiation and piping in accordance with manufacturer's ratings, to insure the owner an efficient and economical apparatus?"**

### DISCUSSION.

Mr. Kent: "Should the heating engineer be expected to insure the owner an efficient and economical apparatus?" That is jumping from the first line of the question down to the last. He should do everything which is necessary to insure the owner an efficient and an economical apparatus. That is what he is hired for, and that is what the owner expects, and there should not be any question whether there is reserve power or just barely enough, he ought to give satisfaction. But he ought to have it clearly understood before he begins to put in any heating system exactly what he is going to put in, so much heating surface and so much grate surface, and then the question answers itself: He should not be expected to put in anything more than he agrees to put in. I think this matter of reserve power must have come up from some question or complaint that came in after the installation of a heating plant, where the owner wanted to satisfy his tenants. The trouble might not have been as to reserve power in the heating boiler at all, but in the chimney. But really such a question cannot be answered definitely, unless we have the whole of the facts before us.

Mr. Lyman: An officer of a well-known heating company told me a few days ago, that the practice in the West was that if a boiler was rated to carry a certain number of feet after making the usual allowance for radiation, piping, etc., an additional factor of safety was allowed of from twenty-five per cent. to fifty per cent., before they took the manufacturer's rating for the boiler. And then he mentioned as an illustration, a boiler manufacturer who used the usual formula which is found in the guaranty of the boiler manufacturer, but whose boilers would not stand up under as much net radiation as they

were rated for, if no allowance was made for piping, or for the factor of safety. I suppose the question may refer to some such case. But the heating engineer must be expected to allow for such factors if he questions the ethics of the manufacturer as regards rating.

Mr. C. B. Thompson: I look at this question a little differently from Mr. Kent, that is, my impression is different; I think the man who asked that question had in mind the various ratings made by the manufacturers, and he says in effect, "Can I take the manufacturer's rating, and after allowing for my condensation and cooling power, and my radiation, and allowing for all piping and fittings, can I take the manufacturer's rating as being proper, so that I may install the plant in my client's house and give him a fairly economical result?" That is the way I look at that, and I believe that is where it hinges. I believe it hinges on the method, or lack of method, of rating boilers by manufacturers. I may as well state my position. I have been in both ends of the business. I have been a heating contractor and I have been with the manufacturers, and I am now with a manufacturing concern, manufacturing boilers, and I have been with the American Radiator Company a number of years, and conducted quite an extensive series of experiments on house-heating boilers for them, and I learned a few things that I did not know before, and I have some to learn yet, I suspect. But one thing has struck me at these meetings, that this body of scientific men, more or less scientific, some of them having highly technical educations, and there being none of them but what have had practical experience—that they will come here and complain, and I have heard the complaints for fifteen years—I have-heard the contracting steam fitter complain that the manufacturer does not give them the proper rating of boilers. But I have never yet heard a suggestion how boilers should be rated to please everybody. Now the German method of rating a boiler is this: The German engineers do not ask you to tell them how many feet of radiation the boiler will carry, but they do ask you for the potential of your heater. And the way they arrive at it is not correct, as I think. They connect their boiler to the tank instead of using the evaporation tests. They put it on to a tank of water, and they run it at its maximum with a strong draft

from two to four hours, and then they note the transmission of heat per square foot of heating surface; and on that basis they give you the boiler's potential per hour in calories. I should say that they first deduct from that maximum an arbitrary percentage, probably twenty per cent.—I know it is so in some cases—to allow for a lower rate of combustion which they think may be fairly expected; and then they give you the boiler's potential at so many calories per hour. Now the engineer has that before him; and he does not say it carries so many square metres of radiation, but so many calories. So, then, he has an arbitrary factor for dividing, and while he cannot get accurate data as to the emission of heat, he lumps it, and he says that the water radiator, under normal conditions, will emit, say, five hundred calories per square metre per hour, or in the case of steam seven hundred and fifty. And so he takes those two factors, and, according as it may be a water or a steam job, he takes the total calories, may be 40,000, per hour, and divides that figure by 500 or 750, as the case may be, for water or for steam. The objection to that is that the time factor is not there at all, which I consider important; I may be wrong, but I am here for correction; I believe the time factor to be the great factor in house-heating boiler rating, and that is entirely lost sight of. Well, after you get that, after they start to put up the boiler they must try by experiments how long the boiler will maintain that rate of combustion, and give them the potential that the boiler manufacturer says it will have. So it has led to this, in German practice, that the manufacturer will crowd all the heating surface he can into the boiler. I know a case where a certain boiler was made for the German market, and it did not prove as efficient as it should. The trouble was, as a matter of fact, that there was not room for the fuel, but cutting out some heating surface made the boiler more efficient. But the engineers in Germany would object to that, inasmuch as they base their boiler capacities on the number of square feet of heating surface and the transmission of heat from that heating surface, and they would think that the boiler would not have as great efficiency if any of that heating surface was cut out.

I believe that I have said that I was rather surprised that in this body of heating and ventilating engineers they have not

taken up this subject and appealed to the manufacturers and told them what they want. What is the good of quarrelling with the manufacturers and not suggesting to them what you want? You will pay just as much for a radiator that only emits one and one-half units per square foot as you will for one that emits two. But if I told you that I had a radiator that will do thus and so, and emit so many heat units per square foot per hour, you would laugh and say: "I do not care about the efficiency, what is the price?" Now I do not believe that is right. The engineer must get down to a common sense basis. And he has got to demand of the manufacturer, to go to him and ask exactly what his particular manufacturing company will do. He must state to him: 'What is your radiator's efficiency? What is the boiler's efficiency?" If I tell you a boiler's potential is so many heat units or so many pounds of water evaporated at 212, what is the next step? If you know the emission of heat by radiation, and the boiler's potential, you can divide the boiler's potential into any number of hours that you like, providing the boiler is properly proportioned. But on that question every man has his own idea. But if this matter were put to the manufacturer, and you insisted that he must provide you with his boiler potential, or the latent power of the boiler, that is to say, the power extracted from a full charge of fuel, leaving a reserve for re-coaling, and taking the fuel available, then you would have something to go by. I am not one of those who believe in having a smoke-pipe that chickens can roost on at night. I believe you must have a certain rate of combustion so as to get the best rate out of your fuel. But I would not accept a house-heating boiler from any man that would not maintain its rating eight hours continuously at its maximum temperature. If you would come down to that you would find that all this trouble would be eliminated. There would be nothing to do but take the boiler potential, divide it by the hours you expect the boiler to run, divide by your cooling factor, and you would know more than any manufacturer about it.

Mr. Quay: This discussion is practically taking the subject out of the heating engineer's hands and putting it into the hands of the boiler manufacturer. But it does not seem to me that the heating engineer should depend on the boiler manu-

facturer's rating of the boiler, as there are so many different conditions under which the boiler has to be run, especially for house heating, and it seems to me that the heating engineer should decide himself what size and kind of boiler he wants for a certain building, the grate area, and the proportion of the grate area to the heating surface should not be left to the manufacturer, as the manufacturer is making his boilers for sale. As to the question of reserve power, I think there is no question but what there should be reserve power even in a heating plant. If it comes to a question of a power plant we do not question that at all. We always have a reserve power, and if the plant is large enough we have a reserve boiler. It is more important in the power plant than in the heating plant, because the usage is harder, and we find it necessary to have a reserve boiler in case of emergency.

Mr. Barron: I agree with Mr. Quay. I also think the German and French engineers are perfectly right. My experience has been like that of the man who raised this question. I have been at a distant time an engineer for a boiler manufacturing concern and I have been a contractor, and I know from both points of view that the man who should decide is the heating engineer. The man who designs the plant should know the potential of that boiler, and should design a boiler for the work that is to be done, and he should always design it, as maintained by Mr. Harvey last night, with a reserve capacity. A vertical tube boiler is in my belief the right one. A horizontal water tube boiler cannot be forced. Heating boilers do not differ from ordinary power boilers except to a slight extent. It is simply a matter of boiling water, and the engineer should know the grate surface, the fire-box surface, the heating surface, and all the details of the construction; and he should have reserve power. My contention is that all the knowledge in Mr. Kent's Mechanical Engineer's Pocket-book on shell boilers and all the knowledge on shell boilers in Professor Carpenter's work "Heating and Ventilation"—I think that knowledge is all obsolete. I think that shell boilers and cast sectional boilers, which are also shell boilers, are out of date. I believe that all that knowledge should be thrown into the scrap heap. We have got into a new period, the period of the water tube boiler, and that should be in the vertical form.

I am speaking, however, only generally, but I claim that water should be allowed to circulate freely, and then to have a certain reserve capacity which you can get out of the boiler by complete combustion with quick firing. Most of the boiler manufacturers to-day come to the contractor and want to put in a large boiler; they want to be safe, to be sure that you are going to cover your mains, and all that sort of thing, because they are afraid of their boiler. Cast iron men know that their boilers are inadequate in heating surface. The old heating men, our predecessors, the men we learned our trade from, took the ordinary boilers in the market, and they figured up the heating surface, and they designed a boiler for the plant they were to use, and they got very good results in a great many cases, just as good results as we are getting with our new system. We take the rating given by the boiler manufacturer, making a certain discount for each particular maker. That is, you use your own judgment and you risk certain boilers. But there is always this risk, and whoever framed that question had that in view. I judge it was some contractor's trouble with small boilers, who found that he had to force the boiler all the time, that suggested the question. My contention is that the engineer is the man who should take the responsibility.

Mr. C. B. Thompson: In regard to what my friend has said in respect to the heating engineer being the man who should decide, I cannot at present agree with him. I think the manufacturer makes the boilers, and he is making them for profit, and he is asking the heating engineer to pay him that profit; and if it is not up to him to test the boiler I should like to know who should test it. Now, gentlemen, I don't think it is trickery on the part of the manufacturer; I believe the majority of men are honest; it is largely ignorance. And then when you come to say that that the heating engineer must decide these questions, as regards heating surface, area of grate surface, and fuel capacity, which I have spoken about less than anything else, though it is the one important factor—when you come down to that question you must remember that there are only few men in the heating business capable of doing that. How many men can take a boiler, analyze it, and place the heating surface that stands in different positions throughout that

boiler, and tell you the value of that in heat transmission? I have seen square feet of boiler surface whose transmission would range from 1,000 to 9,000 heat units per square foot per hour. I have known of a boiler whose transmission was 6,000 heat units per square foot per hour, and I did once see a boiler which ran as high as 9,000, so, of course, the fuel was being wasted; but when you consider that vast range, you can see the possibilities of getting the thing somewhere near right, and you can see the impossibility of the ordinary man, who has not been educated technically and perhaps has had but a limited experience practically, understanding it. You can see the difficulty he would have in analyzing a boiler and getting it exactly right. Possibly I might make a stagger at it, because I have had an extensive experience, but as a rule I say that the manufacturer himself—and I am in a position to say that—the manufacturer himself will be only too glad to do it. That I know. I know that the leading manufacturers of this country to-day are more than anxious to get rid of the present ratings of boilers. But at present they say to you that number 9, for instance, carries so many hundred square feet of radiation; but conditions are not stated, and they do not state how long it will run. I say house heating boilers should be made to maintain the temperature required on the coldest days. If in New York, for instance, you have only one cold day, that is the day when you want the heating apparatus to do its work.

I believe the manufacturers are wrong—not necessarily in their designs—but still I believe there are boilers put up that will carry the manufacturer's ratings sometimes for ten or twelve hours without attention, while there are other boilers which will carry their ratings only four or five hours. I want to get a basis on which to rate boilers. I want to lay before the engineer a scheme by which he can decide. If a man comes to you and says "I don't want a boiler that will run eight hours, I want a boiler that will only require firing twice every twenty-four hours," you will guess at it, won't you? Now if a method can be presented by which you do not have to guess a great deal, that difficulty will be eliminated.

Mr. Quay: The speaker is talking about one man and I about another. He is talking about the so-called heating contractor, who is often a tinsmith or a stove man; I am talking about the

heating engineer. We expect the heating engineer to understand his business; if he does not he had better get out of the business. And hisown admission is, that of the other manufacturers, that they don't know—claim they don't know. Now the heating engineer ought to know, and I think it is a very foolish thing for the heating engineer to go to the boiler men and ask them what size of a boiler to use for a certain place and take his rating.

Mr. Neiler: I make the motion that the chair extend to Mr. Thompson an invitation to calculate the data he referred to, and that he present them together with any suggestions he may have on that subject to the Society this afternoon.

Motion seconded, put to a vote, and carried.

Mr. Thompson: I thank you for the courtesy extended to me, and the data I will give you will be more in the form of suggestions than anything else. I will endeavor to present them in such a form as I hope may at least meet with your consideration.

## TOPIC NO. 6.

**"Are there any advantages in the use of vacuum systems of steam heating for residences?"**

Mr. H. A. Joslin: I think myself there is quite a little economy in the circulation of steam below the pressure of the atmosphere. It is a question how it can be done to the best advantage. We know that in the fall and in the spring you cannot put in several units of heat to one room. You can only put in one unit of heat usually, and in doing that, when you fill up with steam under two pounds it is going to give off a certain amount of heat. If you can reduce that temperature so that it will impart less heat during the spring and fall there must be economy in it.

Mr. Paul: The question of vacuum systems really does not distinguish between the many that are at the present time exploited upon the market, and therefore the only way I can speak to the question is to talk upon the broad results of the experiments which I have made. These experiments have satisfied me of the great advantages of a system of circulation of steam at low temperatures—leaving out all question of the

vacuum systems. Of course, if you have means of some kind whereby you may be able to remove from that system air, the only thing you desire to take out of the system, the service will be much more efficient. I mean by that, the heating surface both of the boiler and of the radiators will be more efficient. The lower the temperature of the heating surface the less heat will be emitted; but at the same time there are other factors in the situation which make it economical to reduce the temperature of the heated surface. The question of circulation being entirely omitted from consideration, and there being a forced circulation by increasing the pressure of the steam, you are able to run your force up without sending too much hot gas up the chimney without getting any benefit from it. I made tests in a private house before I introduced any system upon the market; but those tests gave no commercial basis for the system. But after taking up the business a system was installed in a house, near Boston, that had formerly been run with a pressure system, but, like many pressure systems having indirect surface and direct surface, one would rob the other under certain conditions, and therefore it was not satisfactory. We made a contract whereby the owner was to put in the system and circulate the steam independently of the question of heavy fire or pressure on the boiler. There was no guarantee in regard to saving; we did not know anything about it; we merely said that if it was not satisfactory he might return the apparatus and we would not ask him a cent for it, and if he was satisfied at the end of two or three months he might send a check. He came in some time after and said, "You have not sent in any bill." We said, "No, we have sent no bill, but if the system is satisfactory we expect a check." He said, "Send your bill and I will give you a check." Two years later I said to him one day, "How much did you save?" He said, "I formerly burned 15 tons of coal per year to heat my house; I now burn 8⅜ tons." Since that time I have asked him two or three years later, how the thing was working, and he said, "I have never burned 10 tons and I formerly burned 15 tons." His way of measuring the amount of coal that he burned was this: He filled his coal bins full, and his coal bins held 13 tons of coal. He was always obliged to put in two tons more in order to heat his house through the season. And he

said that after he had introduced the system of circulating steam below pressure of the atmosphere he then used whatever he wanted out of the bins he told his coal man to fill his bins, and the coal man charged him with 8⅝ tons. That was the way of finding out the quantity he used. Of course there is a question whether it is policy to heat our rooms with the radiating surface so near the temperature we require in the room, or whether it is policy to have a very high temperature in our radiating surface, that is, to make more difference between the temperature of the room we are heating and the temperature of the heating surface. My theory is the nearer the temperature of the heating surface to the temperature of the air used, the greater the economy.

Mr. Barron: My contention is that all vacuum systems are wrong, that they are an engineering delusion, a serious mistake of the engineers. As a matter of fact the vacuum system is a pressure system. I am looking at James Watt's picture on the wall. He was engaged in the steam heating business and he worked the steam on the highest pressure he could get, so he thought 5 or 10 pounds was sufficient. He had a contemporary, Perkins, who worked up to hundreds of pounds, and he is the father of steam heating—and I am wondering what they would think of us if they could see what we are doing now with our low pressure systems. My contention is that we are making a tremendous mistake in our boilers, radiators, and in our whole systems of heating; that our present gravity low pressure system is a serious mistake, and that the engineer of the future will regard us as a timid race of men, as men who could not take chances, such chances as Watt and Perkins took. Our radiators should be made to stand 500 pounds, our pipes the same way, and they should be so constructed that a reasonable pressure of 100 or 200 pounds could be carried for heating, and that might be increased, when necessary, so that you would get an immense variation on account of the capacity of your apparatus. You would require much smaller pipes, boilers, and radiators. Low pressure gravity systems with their limitations and balancing of pressure, and having large pipes and radiators, will be done away with in favor of high pressure. And we shall see, in our life, the gradual displacement of our systems of heating, and we will be forced to put in

high pressure boilers and high pressure pipes. Low pressure systems and the delusions of vacuum systems are more or less erratic forms of engineering. In the development of mankind there have been lots of erratic things which have survived a long while. They may fit our systems to-day. They fill a want, and they have good qualities, and one system may be very much superior to another system, but speaking in generalities —the only thing we can talk about is general systems,—I contend that the whole idea permeating the heating and ventilating fraternity, and the whole world, I may say, is wrong. The French and German engineers are crazy on vapor heating, and I claim that is all wrong. And I claim that the idea of carrying high pressure on the boiler and heating systems is the correct idea. If the old-timers could come back they would not understand the necessity of agitating high pressure, because they believed already in high pressure; but we have to do with it, because we have been permeated with the low pressure idea.

Mr. H. A. Joslin: I think Mr. Barron must go down on the stock exchange once in a while, he deals in futures so much. (Laughter.) I read a paper before this society about five years ago, giving the results of a test made at Ohio University where live steam was taken through a reducing valve and the condensation weighed, which is the only practical way to know how much steam you are condensing, and that test was made under 5 pounds pressure. It was also made at or below the atmospheric pressure, and the weight of condensation given in the report at that time—it was made by the engineer of the university himself—and showed a saving in the steam condensed and the temperature maintained, of over 17 per cent. Those are facts and cannot be controverted.

Mr. Connolly: I would like to ask Mr. Barron if it is a delusion and a snare, instead of buying 15 tons of coal at the present prices to buy $8\frac{5}{8}$ tons at present prices? That was Mr. Paul's statement.

The President: I think Mr. Paul's statement was that under pressure he burned 15 tons of coal, and $8\frac{5}{8}$ tons under a vacuum.

Mr. Barron: Certainly it is not more economical to burn more coal.

## TOPIC NO. 7.

**"For plants where the steam pressure does not exceed 100 pounds, which is to be preferred, a water-tube or a fire-tube boiler?"**

Mr. Barron: If the gentleman that proposed that question is here I would like him to define it.

The President: Is the guilty party here? I believe this and the subject following relative to Flanges would be a good subject to discuss, and probably some of you who have had experience may give some of your ideas in connection with it. This appertains particularly to power plants work, and we are all getting more or less of that in our construction work, and the engineers are having more of it to do at the present time than at any other time during the history of the profession.

Mr. Joslin: Can't we take up both subjects and discuss them at once?

The President: Yes, you can take up No. 7 and No. 8.

Mr. Kent: The grounds of preference may be various, but it seems to me there is only one reason for preferring the fire tube boiler over a water tube, and that is its lower cost. I have not been able to prefer it for any reason except that. But when a man can get a water tube boiler and is willing to pay for it, that is the kind of boiler to be preferred for all pressures above 40 or 50 pounds. If you get 100 with a horizontal fire tube boiler it will not be very long before the insurance companies are rating it down to 80 and afterwards to 60. And it has a limited and uncertain life. The questions of durability and repairs are against the fire tube boiler, and the water tube boiler is displacing it for every purpose except lower cost.

The water tube boiler has shown the highest and also the least economy, and the same may be said of other types of boilers. The question is not of the boiler but of the furnace, the coal and the method of handling the coal. I recently had occasion to make a test of a water tube boiler, and got very poor results, but the furnace was not adapted to the boiler. And wherever you find a low result with a water tube boiler you can set it down not to the boiler, but to the conditions, and the main condition, when soft coal is used, is the furnace. With good furnaces they usually come out ahead.

Mr. Barron: The reason the water tube boiler is superior to the fire tube boiler lies in its safety. We read of explosions every day in the paper, but the water tube boiler in any form is relatively safe under average working conditions. And as I stated before, I am satisfied that everything Mr. Kent has said about the water tube boiler is correct. I know men who are building economizers. Now, due to certain reasons, they prefer that shell boilers should be put in. To me that is out-of-date engineering. All they realize is the difficulty of designing a water tube boiler to meet certain conditions, and they can adapt the shell boiler easily; and they prefer the shell boiler for that reason. But on exact principles of engineering I don't think there can be any such preference for one minute, because every engineer would prefer to deal with something absolutely safe, and which can be worked under any conditions at any pressure.

Mr. Kent: One great reason why the water tube boiler is coming in is the space. It takes less space than any other. I had recent occasion to make a test of water tube boilers running a brewery. They had put out of service a horizontal fire tube boiler which was condemned by the insurance people. They got water tube boilers of a little more heating surface and rated at a little higher horse power, and they could not make a brew without the pressure running down. They were about to condemn the boilers when I made the tests, and I found the trouble was entirely due to the firemen. On account of the grate surface being a little smaller than that provided for in the tubular boilers the fire had to be driven a little harder, and the firemen were entirely ignorant how to handle soft coal to burn rapidly. They let the fire smoulder and then they did not break up the caked surface. "You must wait until the fire comes up," said the old fireman. They got another fireman that showed that man how to work it, and the result was that they ran two brews consecutively, and had the safety valve blowing most of the time, and ran the boiler up 60 per cent. above its rating. And there was nothing changed except the method of firing. There the water tube boiler came out ahead, by changing the method of firing to suit the smaller grate surface.

## TOPIC NO. 8.

**"What is the largest size of pipe that should be used with screwed joints only and without flanges?"**

Mr. Barron: I read a paper some years ago on screwed flanges under heavy pressure, and it was discussed by several members, and my recollection is that the impression left was that above six inches it was not safe to use screwed work, *i.e.*, it was not convenient. That agrees with my practical experience. Up to 6 inches the screwed pipe has many advantages, practical, and commercial, and otherwise. Above that it is more advisable to use the flanged pipe. I have done work where all the pipe had to be flanged from 2½ inches up, but up to 6 inches we use screwed pipe; above that flanged pipes are more convenient.

Mr. Maloney: What are the practical advantages or disadvantages of using pipes from 6 inches up to 12 inches with screwed joints, providing that flanges are introduced in sufficient number on long runs to make it convenient to take the pipe apart?

Mr. Barron: Between 6 and 12 inches I think there are decided advantages in making pipe joints with flanges, because where you are paying men four dollars a day for eight hours' work, screwing 10 and 12 inch pipe, it takes a good deal of time to make the pipe properly line when you are depending on the screwed threads. When you get above these figures it takes two or three men to handle it, and it is not as easy for the men to make good work, and when you put it up above 6 inches you have leaks difficult to fix, and very often the only remedy is by taking the pipe out and putting flanged pipe on. It is simply a matter of practical working and convenience. I have had some screwed work recently up to 8 inches and there was some difficulty about it. As the sizes get higher there are difficulties in getting the pipe properly hung and so on that usually determine the engineer not to go above 6 inches with screwed joints.

Mr. Maloney: There is a point which puzzles me in putting pipe together. I can mention a case where we have probably 1,000 feet of piping, which runs from 12 inches down to 4 inches, and the question came up of having screwed joints or

flanges on the 12-inch pipe. I found that in using the flanges on 12-inch pipe, practically it has as many joints as one without the flange. I could not see where the advantage came in, of using flanges and screwing those to your 12-inch pipe, over screwing a 12-inch pipe well together.

Mr. Connolly: I believe Mr. Barron means welded flanges.

Mr. Barron: No. Either one. My explanation would be that you screw up these 12-inch flanges on the floor or in the chuck of the pipe machine, and it is an easy matter to make a good job. It is quite different where you screw 12-inch fittings. They are not as good and there is danger of bursting them or starting the pipe to leaking.

Mr. Kent: Does not Mr. Barron peen over the ends of the pipe.

Mr. Barron: We have never found it necessary. But that is often done and I see no harm in doing it, but I have never found any necessity for it.

Professor Kinealy: I have called for screwed joints because of the very reason advanced by Mr. Barron. When the pipes are flanged it is not necessary that they should be lined up so carefully as when they are screwed. I have put in pipes for low pressure as high as 12 inches, both screwed and flanged, but the workmen in putting in the pipes where we had screwed joints, were obliged to line those pipes up or they could not get them together. Where flanged joints were put in we would have three or four broken flanges simply because they bolted the pipes up tight, and when we turned on steam, having long lines of pipe, the flanges gave way. I have, therefore, with malice aforethought, insisted that we have screwed joints on the large-sized pipe, for the reason that I know that they have to be more carefully lined up, even although these pipes were to be used only for low pressure.

Mr. Maloney: Professor Kinealy's remark corresponds with the results of my own practice, on the job I referred to. In a run of practically 1,000 feet 90 per cent. of the leaks, under a pressure of 20 pounds, showed up in the flanges.

Professor Kinealy: Of course when using very high pressure which justify putting money enough into the work, I should use flange joints. In my boiler room work for high pressures I use flange joints. In long runs of pipe for heating with low

pressure, where the workmen know that the pipes are to be subject to low pressure, I am inclined to insist upon screw joints.

Mr. Quay: I heard our president say last night that heavy flange work was being done, where they did not use any gaskets. I think this a good method (of facing the flanges together) for high pressure work. If the question refers to low pressure I think I would agree with Professor Kinealy. I would only use enough flanges for the disconnecting and connecting of the pipes. On high pressure work of large sizes, we have often used shrunk flanges and peened the pipe. The specifications sometimes call for all flanges being peened. If flanges are peened there is no movement, and the question of contraction and expansion has to be taken up by the use of screwed fittings for this purpose. You have to use a great deal of judgment. You cannot lay down any arbitrary rule. The different conditions require a different class of work. There is an objection, of course, to having too many flanges, especially if you use gaskets in them.

Mr. Rutzler: There seems to be an impression that it is well to use as many flanges as possible. My advice is to use as few flanges as you can possibly use. Flanges should be used only where you have large valves, large fittings, which possibly you might have to take out and change for different reasons. They are of no earthly benefit to your work, and they are not equal to the screw joint if properly put together; and if you gentlemen are doing work along that line you should have men that are competent to screw pipe together so that it will stay. Take the flanges on a long run, and the expansion affects that, when you put steam on it, presses your copper and such things together, and when it contracts you have a leak, and the first thing you know you have a new joint to put in. The less flange joints you have in your work, in my opinion, the better for the work and the job.

## TOPIC NO. 9.

**"Has the modern construction of air valves provided a satisfactory substitute for the positive air valve?"**

Discussion by Mr. Joslin and Mr. Wolfe.

## TOPIC NO. 10.

**"In heating swimming pools, does the body of water bear a relative proportion to the grate surface in the heating apparatus that is similar in steam heaters and water heaters, and does the method of application change this relation?"**

Mr. Kent: I think the question of heating swimming pools is a question of the number of heat units to be used in heating the pool. It depends on the size of the pool, the amount of loss by radiation, and the amount of water circulating in the pool. There should be no difficulty in regard to application in that and other places. So much heat required per hour, so much grate surface.

## TOPIC NO. 11.

**"Has the recent scarcity of coal aided in the perfection of fuel oil burning devices to make them practical for use under apparatus for heating buildings and the industrial purposes, and are such devices obtainable?"**

Mr. Wolfe: I may be able to give a little information that may save us all a little trouble in this relation. I heard from the head of the Department of the Standard Oil Company who finally passes on the calorific values of the oil, etc., that as against a ton of anthracite coal it would take of standard kerosene—150 test—$26 worth of oil to produce the same number of heat units that would be contained in one ton of pure anthracite coal. Twenty dollars' worth of kerosene oil appears to be the equivalent of one ton of pure anthracite coal, which contains 14,500 heat units. That is refined kerosene, at 150 test. That does not apply to crude oil. This, I suppose, refers to home consumption for furnace work and things of that kind. You cannot buy crude oil in small towns.

Mr. Dean: I recently called on a friend in Boston who had just placed an oil burner under a cast iron boiler. It was guaranteed to heat the man's house and to consume oil not to exceed the cost of coal at $6 per ton. When they got the apparatus installed and ready to test he put in a barrel of oil, 32 gallons, lighted the fire, and in one hour's time, or perhaps two hours'—I am not positive about that—within a very short time they had burned the 32 gallons of oil, and had raised the temperature of the house from 58 degrees to 68 degrees, and that was the best they could do. The boiler the burner is in is rated

to carry in the neighborhood of 1,000 square feet of hot water radiation, and has carried it satisfactorily for several years, using hard coal. It is a hot water job, and after making one more effort with practically the same result, they took the oil burner out. On the other hand, I was recently in Beaumont and they are burning crude oil very satisfactorily, with high pressure. It is also being used on the locomotives. It seems to be giving satisfaction in every way. Of course the price of crude oil at that point and at other points is a very different thing.

The President: Is there any other gentleman who has had experience in burning oil?

Mr. Meyer: The question has been asked whether the high price of coal due to the strike has had any effect on fuel oil-burning devices? I think it unquestionably has. It has caused a good many people to look into the question. Members of the Society will find some valuable data on the subject in the recent annual report of the Chief of the Bureau of Steam Engineering, U. S. Navy. It contains a report upon a large number of experiments made upon a boiler fired with fuel oil and with different kinds of coal. Another interesting point: I have been informed that a firm which for some time has manufactured crude oil burners went out of business for the simple reason that oil could not compete with coal as fuel.

Mr. Kent: I discussed this subject in the September number of *Power*, in a long article on the whole question of coal oil, but did not touch on the subject of kerosene. It was a question of crude oil. My conclusion was that whenever you can buy three and a half or four barrels of crude oil at the price of a ton of anthracite coal, that it pays to burn the oil. But in all ordinary places in this country, where coal is reasonably cheap and oil high, it does not pay to burn oil. But there is one great difficulty in burning oil. There are plenty of burners, and plenty of ways of burning without smoke, when you rig up for it, but the great objection to burning oil is because of the cost of the oil and the certainty that if oil came largely into use the price would be advanced—so that the amount of oil used is going to be a very small fraction of the amount of coal.

Mr. Lyman: One phase of this question has not been touched upon. Some years ago a friend of mine adapted his burners to

oil, but the first thing he ran against was the insurance companies; and is not that, in domestic use, an important objection? The question of insurance makes the question of oil burning in domestic-heating plants a difficult one.

Mr. Blodgett: The gentleman has brought up the question about violating insurance requirements. I have studied the question a little myself, and have read over my insurance policies; and as I read them I found that none of them prohibit you from keeping as much as a barrel of oil on your premises at any time. Referring back to the utility of burning oil in comparison with coal, I noticed an article in the paper a few days ago—I think in the *Herald*—which purported to be on the basis of some experiments made by some institution in Massachussetts, I don't remember now which. They had experimented with wood, with coal, with oil and with gas, and had figured it out to the quantity of heat units that would be produced by a dollar's worth of fuel of the various kinds, and if my recollection serves me, the oil only cost about 25 per cent. more than coal at $12 a ton.

## TOPIC NO. 12.

**" For soft coal burning, what changes are necessary in a hard coal apparatus to secure efficient heating, prevent soot production, and to render the management simple and avoid excessive waste ? "**

## DISCUSSION.

Mr. Kent: It is a very easy thing to answer that, but not so easy to put it into practice—the question runs: For soft coal burning what changes are necessary in a hard coal apparatus? You must make the combustion chamber from three to ten times as large as in the hard coal apparatus, and line it with fire brick, and you must provide means ıor mixing very hot air with the gases distilled from the coal, and provide a long run for the gases, so that the combustion is complete before they are allowed to impinge on the heating surfaces of the boiler. If you have a small anthracite furnace and wish to adapt it to burning soft coal, place a large fire-brick oven in front of the anthracite furnace, and use the latter as a combustion chamber. The conditions for burning soft coal without smoke are: the gases must be distilled from the coal slowly. The soft coal

must be fired in small quantities at a time. The gases must be mixed in the combustion chamber with very hot air, and the gases must not be allowed to impinge on any cooling surface until they are thoroughly consumed. The great thing is to provide a very large apparatus. After you have done that the management is simple and you can achieve perfect results by half a dozen different methods.

Mr. Wolfe: I think the most economical thing that could be done to effect a change would be to buy a new apparatus.

Mr. Quay: If this refers to a power plant, a large plant, you may make the change by using some kind of furnace that is made for this special purpose of using soft coal, not only to prevent smoke, but to obtain the same or better results than by using hard coal.

# TRANSACTIONS

OF THE

# SEMI-ANNUAL MEETING

Niagara Falls, N. Y., July 17–18, 1903.

## CXIII.

# THE AMERICAN SOCIETY

OF

# HEATING AND VENTILATING ENGINEERS.

### SEMI-ANNUAL MEETING.

**Held at the Cataract House, Niagara Falls, N. Y., July 17–18, 1903.**

## PROCEEDINGS.

### FIRST SESSION.

The meeting was called to order by President H. D. Crane at 2:30 P.M., July 17th.

The President: Gentlemen, you will please come to order. We will proceed with the roll-call.

Secretary Mackay: Before calling the roll I would announe the names of the following persons who have been elected to membership since the last meeting:

NEWLY ELECTED MEMBERS ANNOUNCED AT SEMI-ANNUAL MEETING, JULY, 1903.

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|---|---|
| John B. Bernhard, Portchester, N. Y...... | Member. |
| W. L. Bronaugh, Chicago, Ill ............ | " |
| Edmund F. Capron, Chicago, Ill ......... | " |
| Frank B. Darragh, Pittsburgh, Pa........ | " |
| Henry L. Doherty, Denver, Colo.......... | " |
| E. J. Febrey, Washington, D. C.......... | " |
| Frank C. Goff, Denver, Colo.............. | " |
| Walter Leek, Vancouver, B. C........... | " |
| Neil W. MacIntosh, New York .......... | " |
| H. C. Mallory, New York................ | " |

| | |
|---|---|
| Frank G. McCann, New York | Member. |
| Frank C. McLain, New York | " |
| Chas. J. McPherson, Portland, Ore | " |
| Jas. J. Walker, Pittsburgh, Pa. | " |
| H. A. Wilson, Boston, Mass | " |
| Albert A. Ainsworth, New York | Associate. |
| John K. Allen, Chicago, Ill. | " |
| Henry M. Carruthers, New York. | " |

The Secretary then called the roll, and reported that a quorum was present.

The President: Gentlemen, I congratulate you on coming here in even the numbers that you have. I recognize the fact that a summer meeting, at best, is not to be expected to be attended very largely; nevertheless the summer meeting is held to keep up the interest that this Association has at heart. In reviewing the work of our Association in years past, the result is certainly very encouraging. We have built it up from an association that at one time we were fearful would not really culminate in very much; but to-day in looking over your roster you find upon its pages nearly all of the very best men in our particular line of business, and more are coming to us. This last year, I am glad to say, has been a very satisfactory one in every way, both as to the number and the character of members that we have elected, and as to the finances. Before the next meeting we will have in our hands both volumes of the Proceedings of our meetings, which undoubtedly will be very satisfactory to you because of the fact that we now have almost daily use in our offices for these Proceedings.

I am not going to attempt to make any address. I thank you gentlemen for coming to this summer meeting, and I hope that you will benefit as much by it as I expect to do myself.

We will proceed with the reading of the first paper on the the programme: "Description of a Low Pressure Steam Heating System, which Proved Defective in Operation," by John Gormly, member of our Society.

The paper was read by Secretary Mackay in the absence of Mr. Gormly. It was discussed by Messrs. Dean, Smith, Kent, Chew, Cobey, Ashworth, Galloup, Thompson, Roys, Secretary Mackay and President Crane.

Topic No. 1, "What is the Proper Method of Rating Steam and Hot Water Boilers for Heating Purposes?" was then discussed by Messrs. Kent, Thompson, Ashworth, Mackay and Cobey.

Topic No. 2, "The Relation of Space between Sections to the Efficiency of Steam and Hot Water Radiators," was discussed by Messrs. Dean, Mackay and Roys.

Topic No. 3, "The Advantages and Disadvantages in the Use of Wrought or Sheet-Iron for Steam and Hot Water Radiators," was discussed by Messrs. Martin, Cobey, Roys, Switzer, Kent, Mackay, Chew and Harvey.

Topic No. 4, "Can a Wrought-Iron Nipple for connecting Radiators be Made Durable by any System of Coating?" was discussed by Mr. Millard.

On motion the meeting adjourned until 8 P.M.

## SECOND SESSION.

The meeting was called to order by President Crane on Friday evening, July 17th, at 8:25.

President Crane: We will hear the report of the committee on the tenth annual meeting.

Mr. Chew: Mr. President, at the request of the Chairman, who was the original proposer of the idea of celebrating at our tenth annual meeting the anniversary of the formation of our Society, I read the report for him.

Mr. Chew read the following report:

## REPORT OF TENTH ANNIVERSARY COMMITTEE.

**Submitted at Semi-annual Meeting, Niagara Falls, July 17, 1903.**

Your Tenth Anniversary Committee are pleased to report that much of the preliminary work has been done to make the celebration of our Society's Tenth Anniversary a success, and the feature of our next annual meeting, January, 1904. At the Atlantic City semi-annual, at the last annual, and now, our members have had various ideas exploited, and have been impressed with the desirability of utilizing this opportunity for showing the great value of the work of the Society and the high place it has been accorded at home and abroad.

Now specific work is all that is needed to accomplish all that can be hoped for. Your Committee recommends that the feature of this meeting be the reading of several special papers, in addition to the regular papers. We recommend that where the mastery of some branch has been achieved by some engineer not a member, invitation be extended to such a member of the profession to attend our celebration, and either read a paper or speak on his special branch.

We recommend as topics, "History of the Society," "Heating with Hot Air," "Hot Water and Steam," "School Heating," "Fan Heating," "Temperature Regulation," "Refrigeration and Ship Heating and Ventilation," we recommend that members be invited to take up any of these subjects on which they are especially qualified by experience. We recommend that no paper be accepted for presentation at this meeting that is not in the Secretary's hands by December 1st, so that it can be distributed not later than January 1st. We would also recommend that invitations be extended in person by those of our members who are acquainted with those engineers prominent in our profession who have not as yet become sufficiently familiar with the excellence of our Society's work to join us in it. We recommend that the Society take its part in providing the annual dinner which has hithertofore been so kindly tendered by our New York members. The object we desire is one of vast importance and worthy of the hearty support of every member, but the recommendations of your Committee are so few that success should be secured with but little effort.

Respectfully submitted,

By the Tenth Anniversary Committee,

Andrew Harvey, Chairman.

President Crane: You have heard the report of the committee, gentlemen. What will be your pleasure?

Mr. Ashworth: I move its adoption, Mr. Chairman. (Seconded.)

President Crane: It is moved and seconded that the report of the committee be adopted. Any remarks?

Mr. Harvey: Mr. Chairman, I do not think it is necessary to add anything more to this subject than has already been

said. In the first place this subject was suggested at the annual meeting, I think two years ago, and it has been pretty thoroughly discussed in all its details, and Mr. Chew has been chairman of the committee for one year and he proposed a great many things which are practically the same as are now proposed by this Society. It is a good thing to have milestones along the way, and I think when we come to a place of this kind, if this Society is worthy of its name, that this is one of the places where a grand point should be made so that we can start from this first ten years, and in the ten years to come we can see then the advance that has been made along these lines; I think it will enable people to realize the advance in the heating lines that have been made. This is about as good a way as we could have of making that point, and the suggestions that have been read by Mr. Chew of our committee are, I think, in as concise a shape as we could suggest.

Mr. Chew: Mr. Allen suggests that we might make an effort to have the president of the British Institution of Heating and Ventilating Engineers present at our annual meeting, and I think that is a very good suggestion. There is a German society of the heating and ventilating trades also. Possibly this is an opportunity to invite the members of that organization. Some of the members are aware of the suggestion that we should use this tenth anniversary meeting for the purpose of increasing our membership, that some effort be made along that line. Since that idea was presented, fortunately, the Society has grown so that that is not necessary. One of the original ideas which is partly stated in the report was that this celebration should be used, you might say, to give the state of the art. Well, the topics suggested here for papers would cover that, if the writers will consider it worth while to use that feature in the preparation of their papers. The report suggests that any member can begin by writing a paper. I do not think there will be any trouble about getting papers. I am glad to say that Mr. Stewart A. Jellett thinks very favorably of that, and is strongly inclined to write a paper on the history of the Society, and his deep interest in the Society and his remarks at other meetings would convince everybody that he is well qualified for the work. I have talked with Mr. C. E. Oldacre, who is here in the city and will be present to-morrow

if he is not now—and feel very sure that he will write a paper on furnace heating, describing work quite different from anything done ten years ago, and which he has used successfully. So that we are sure of two pretty good papers for that meeting. Now steam, hot water, fan heating, ship ventilating, and so on, are for some other members of the Society. Let some man who is qualified on any one of these subjects inform the committee through the Secretary that Mr. so and so would be a good man to write a paper on refrigeration or some other man would be a good man to write a paper on school heating, and so on. You notice that we recommend that we do not confine ourselves to the Society; where a man is sufficiently prominent and a master of some branch, he should be invited. If he does not want to take the time to present a paper, we will not, I think, detract anything from the value of our meeting if we invite that man to come and talk, if he cannot prepare a paper.

Mr. Cobey: As I understand, the committee has power to select those that they think qualified to participate in our tenth anniversary, in the reading of papers, etc.

President Crane: Yes, that is the idea—that is, in conjunction with the Executive Committee.

Secretary Mackay: With power to recommend, and if the papers are accepted by the Publication Committee, to have them published.

Mr. Smith: Could not something of this kind be done, Mr. Chairman—the papers to be represented at the next meeting, as I understand these things, are to be prepared for the tenth annual proceedings, for the January meeting. Should not an effort be made and carried out to prevent duplication of subjects? That is, should not that book of proceedings, to carry out the idea of Mr. Harvey and Mr. Chew, be made to cover a diversity of subjects and not be at all a duplication? For example, let us not get in two papers on one subject, even though the two of them may be pretty good. What is the idea of the committee in regard to that?

Mr. Chew: The committee has not considered that, and if we should be so fortunate as to have two good papers, for instance if Professor Kinealy and Professor Carpenter should each take up the fan topic and pursue it to the end, I do not

think the committee or Board of Governors is going to reject those two papers. Yet, as a rule, where any member of the Society has decided to write a paper, he generally notifies the Secretary, and that affords an opportunity to tell that man that already some other man has taken up that same topic, and there is little possibility of duplication of papers on the same topic.

Are you ready for the question? All those in favor of receiving the report of the committee as read and explained, signify by saying aye; contrary, no.

The motion was carried.

Topic No. 5, "The advisability of forming local chapters of the Society in different sections of the country," was discussed by Secretary Mackay and Messrs. Smith, Snyder, Kent, Ashworth, Chew, Switzer, Feldman, Harvey and Cobey.

Topic No. 6, "The relative dimensions, weight and material in piping systems of different diameters working under a steam pressure of 200 pounds or over in pipes, fittings, flanges, gaskets, etc.," was then discussed by Messrs. Barron, Kent, Feldman, Danforth and President Crane.

It was followed by Topic No. 7, "Is there any reliable short rule for approximating the cost of pipe and fittings per hundred feet of surface in heating systems, also the cost of labor?" which was discussed briefly by Messrs. Kent, Cobey and Secretary Mackay.

After the discussion, on motion the meeting adjourned to the following day.

THIRD SESSION.

The meeting was called to order by President Crane on Saturday, July 18th, at 9:50 A.M.

President Crane: The Secretary has an announcement to make, gentlemen.

Secretary Mackay: I would announce that since our last annual meeting we have lost one of our members, Mr. A. H. Fowler, of Philadelphia, who died on June 3d.

President Crane: What is your pleasure, gentlemen, as to appointing a committee, etc.?

Mr. Smith: I move that it be referred to the Executive Committee and that a suitable letter of condolence be sent to the widow.

The motion was carried. The Board of Governors later reported the following resolutions, which were adopted.

RESOLUTIONS ON THE DEATH OF MR. A. H. FOWLER.

The American Society of Heating and Ventilating Engineers has learned with profound regret that one of its members, Arthur H. Fowler, has gone to the Realms of Silence, to take part in our deliberations no more. We are awed by the suddenness of his departure, his robust appearance and cheerful disposition leading us to anticipate for him a long and useful career. His reputation as an inventor was international. He was a profound thinker. His mind was stored with useful knowledge, the product of years of patient research and investigation.

We realize that we must all conform to the fulfilment of God's plan of mortal growth and decay. We humbly bow to His Divine Will, trusting the uprightness and sincerity evinced by our brother, whom we lament, will now be his consolation for all eternity.

We tender our heartfelt sympathy to his bereaved family and pray the God of Mercy to comfort them in their bereavement.

By order of the Board of Governors,

W. M. Mackay,

Secretary.

President Crane: We will have a paper read by Dr. Aylsworth on "The Scientific Basis and Commercial Feasibility of Heat Radiators, using Air instead of Water or Steam."

Dr. Aylsworth read the paper, and it was discussed by Messrs. Switzer, Kent, Cobey, Roy, Feldman, Oldacre, Chew, Schaffer, Ashworth, Secretary Mackay and President Crane.

Topic No. 8, "The effect of Humidity on the Load on Warm Air Heating Systems," was then discussed by Messrs. Chew, Oldacre, Kent, and Schaffer.

Topics No. 9 and No. 10, "The Relative Importance of Grate and Heating Surface in Proportion to Exposed Surface in Furnace-heated Buildings," and "The Relative Value of Firepot and Other Surfaces in Hot-air Furnaces," were

discussed by Messrs. Chew, Switzer, Oldacre, Kent and Shaffer.

Mr. Kent: Before we adjourn there is a question that I have been requested to bring up before the Society by some members of the Society of Mechanical Engineers. Within the last thirty years there have been repeated agitations in Congress to have the United States adopt the Metric system. About five years ago there was introduced into Congress a bill which said that after 1904, I think it was, the Metric system of weights and measures shall be the only legal standard in the United States. That bill never got beyond the committees and was not acted upon by the House. But at the last session of Congress that bill appeared again, with just one word changed—the word "only" was left out, and it provided that the Metric system should be "the legal standard" after 1907. That bill was withdrawn with the expectation that it would be renewed again next December, and that agitation in favor of the Metric system, which has been going ahead for the last thirty years, will be continued. A year ago the National Association of Manufacturers took up the question and sent a letter ballot out to its members asking their opinion of this proposed legislation before Congress and got a letter ballot of about three to one against the Metric system. The American Society of Mechanical Engineers at the last meeting had a paper by Mr. Halsey reviewing the status of the Metric system in Europe, showing that after 100 years the Metric system in France has not yet succeeded in being adopted entirely, in so far as the textile industries in France still use the English system, and the English yard and pound are found in all countries in the manufacture of textile fabrics. Throughout Europe there are probably 500 or more different dimensions which are not Metric sizes, and that confusion is especially true in Germany and Spain. After Mr. Halsey's paper was presented in printed form and thoroughly discussed a committee was appointed to prepare a statement of the arguments for and against the Metric system. Mr. Miller of the *American Machinist*, and Mr. Christie of Philadelphia, were appointed to prepare the arguments for the Metric system. Mr. Bond of the Pratt & Whitney Company and myself were appointed to prepare the arguments against

the Metric system. We brought in this bi-partisan report and that was sent out with a letter ballot to the American Society of Mechanical Engineers. Out of 2,200 men, I think, in that society, only about three or four hundred had enough interest in the question to vote at all. That vote was over three to one, I believe, against the Metric system. It shows that the people in the United States who do the measuring, who are the most interested in the subject, who are the men that ought to be consulted—four-fifths of them do not pay enough attention to it to vote, and of those that did vote, there were three to one against it, so that not over five or six per cent., I think, of the members of the Mechanical Engineers have expressed themselves in favor of the Metric system. The Association of Manufacturers voted the same way, and there are other societies throughout the country that are expressing themselves, and the tendency now seems to be to vote against the Metric system. The last argument on the question has been given by the Metric advocates themselves in withdrawing from the bill before Congress the word "only." They said: "It shall be the legal system," and they have got an opinion from the Attorney General of the United States in which he says that it is impossible under the Constitution of the United States of America to impose any system of weights and measures on the people of the United States; that the English system of weights and measures is a part of the English language, and it would be as unconstitutional to attempt to impose the Metric system on the people of the United States as to change the English language. Therefore, it seems that nothwithstanding the merits which many people acknowledge in favor of the Metric system, it is a practical impossibility to ever establish it in the United States; so that the project might as well be killed now and settled for all time. The question is whether this Society should not take the same action as the Manufacturers' Association and the American Society of Mechanical Engineers took; that is, to send out a letter ballot and ask an expression of opinion from the members, so that that ballot can be placed before Congress in December in case this bill be introduced.

I make a motion that the secretary be authorized, under the direction of the Executive Committee, to prepare a ballot

similar in form to that sent out by the Mechanical Engineers' Society to get an expression from the members of this Society in regard to the Metric system. (Seconded.)

President Crane: Gentlemen, you have heard the motion. Is there any discussion on the subject? If not, I will put the question.

The motion was put and carried.

On motion the meeting then adjourned.

List of members present at the Sixth Semi-Annual meeting, at Niagara Falls, July 17th and 18th, 1903.

MEMBERS.

D. Ashworth
Jno. K. Allen
H. D. Crane
Frank K. Chew
Louis J. Cobey
W. A. Dunn
Mark Dean
J. A. Galloup
A. Harvey
H. H. Hellerman
Wm. Kent
W. M. Mackay
Harry S. Martin
C. E. Oldacre
C. B. J. Snyder
H. A. Smith
Wm. H. Switzer
C. B. Thompson
C. P. Vanderveer

List of guests present at the Sixth Semi-Annual meeting at Niagara Falls, July 17th and 18th, 1903:

GUESTS.

E. P. Allen
Geo. M. Aylsworth
Wm. G. Barrows
G. W. Bowman
J. W. Danforth
A. M. Feldman
J. D. Hoffman
W. J. Millard
W. W. Macon
Chas. T. Pratt
W. E. Roys
John P. Schaffer
Chas. Schwartz
Fred. J. Vaux
H. S. Welsh
C. W. Whedon

## CXIV.

# DESCRIPTION OF A LOW-PRESSURE STEAM-HEATING SYSTEM WHICH PROVED DEFECTIVE IN OPERATION.

BY JOHN GORMLY.

(Member of the Society.)

The writer has permission to describe a low-pressure steam-heating plant which was installed by one not a member of this Society. This plant gave much annoyance and still works in an unsatisfactory manner.

The building in which the plant is installed is used for general stores on the first story, and for offices on the other stories. It has a central section one story in height, one wing three stories in height and another wing four stories in height. The boiler is located under the one-story portion.

A basement story extends under the entire building; in this basement are located two steam circuits or main pipes supplying respectively the three-story and four-story wings. From each circuit branch connections run to the various vertical pipe risers. These connections fall toward the steam main and rise toward the vertical risers.

The building is erected with brick outer walls and fire-proof partitions. It will be unnecessary to describe the building in detail other than to say it is of modern construction of brick with fire-proof inner partitions. It contains about 96,000 cubic feet of space, 11,000 square feet of exposed wall surface and 1,000 square feet of glass surface.

The entire plant contains 1,370 square feet of direct cast iron steam radiation. The mains and branches are not covered by non-conducting material. The boiler used has a grate 27x54 inches, or 10½ square feet of grate surface; 198 square feet of fire surface; height of water line from floor, 57 inches; top of steam drum from floor line, 80 inches; all measurements taken from

maker's catalogue. The boiler is vertical, cast iron, sectional, rated at 1,775 square feet direct steam radiation. The boiler sections are connected together by large cast iron headers nippled to the sections by external nipples at each side, near the bottom and at the top of the sections.

The steam-supply mains rise at the boiler and descend as they recede from that point. The grade is 1 inch in 17 feet.

Each radiator is connected by one pipe to the steam mains and risers; consequently the steam as it advances to fill the radiation is running in an opposite direction to the water of condensation as it flows from the radiator to the steam main.

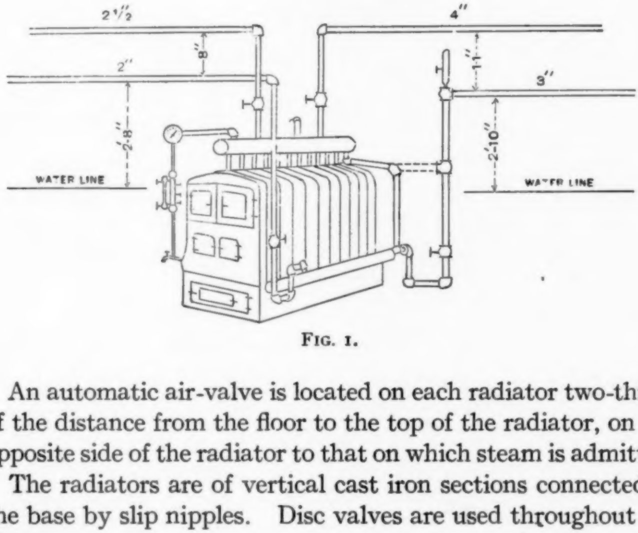


FIG. 1.

An automatic air-valve is located on each radiator two-thirds of the distance from the floor to the top of the radiator, on the opposite side of the radiator to that on which steam is admitted.

The radiators are of vertical cast iron sections connected at the base by slip nipples. Disc valves are used throughout the plant.

The entire length of the building is 100 feet; the width of the building is 25 feet; the four-story portion is 60 feet high, the three-story portion is 45 feet high, and the one-story portion is 20 feet high.

The boiler is located in the basement, 30 feet from one end of the building and 70 feet from the other end of the building. A 2½-inch main supplies the third-story portion of the building from which are taken two 2-inch risers and one 1½-inch riser. A 2-inch return pipe takes condensation back to the boiler from this end of the building. The main steam supply pipe

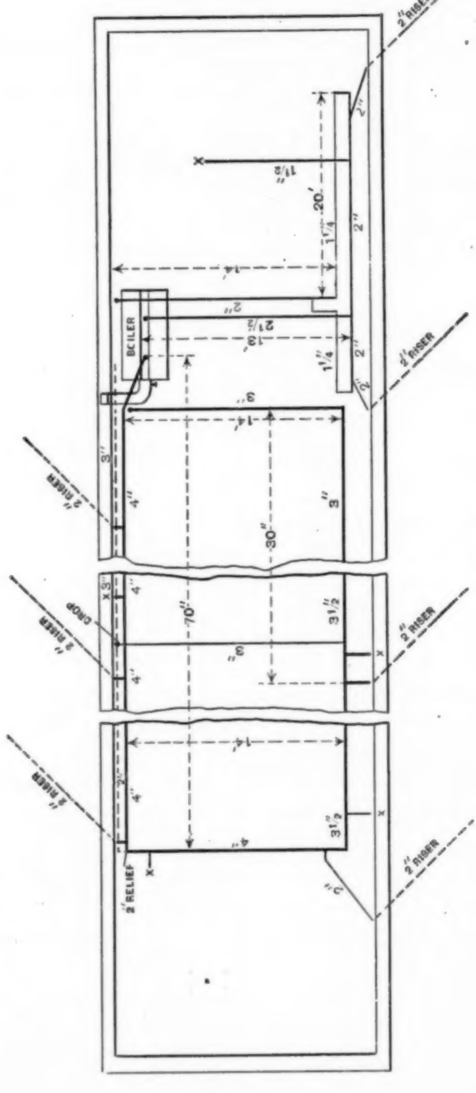
2" RISER
2"
1 1/2"
20'
1 1/4"
14'
2"
BOILER
2"
2 1/2"
13'
1 1/4"
2"
2" RISER
2"
3"
14'
3"
2" RISER
4"
3"
30"
3"
4"
DROP
2" RISER
70"
3"
3 1/2
4"
2" RISER
14'
2" RISER
4"
3 1/2
4"
2" RELIEF
2"
2" RISER

FIG. 2.

runs 48 inches above the water line of the boiler, at its lowest point in the third-story end of the building. At its farthest point from the boiler, it returns above the water line as a dry circuit until it reaches the boiler, where it then connects to one header of the boiler below the water-line. It might be classed as a dry circuit sealed at the boiler end of its return connection. This portion works very well and has given no trouble. This 2½-inch main carries 270 square feet direct radiation.

The other circuit, to the 70-foot run in the four-story end of the building, rises high at the boiler and gradually descends at a grade of 1 inch to 17 feet, where it is relieved of condensation through a 2-inch relief pipe which is enlarged to 3 inches at a point 50 feet from the boiler. This circuit is carrying 1,100 square feet direct radiation. It leaves the boiler and is carried 4-inch in size, a distance of 70 feet to a right angle ell, thence 25 feet across the end of the building farthest from the boiler where it reduces to 3½-inch for a distance of 40 feet and is then reduced to 3-inch to the boiler. It runs above the water line until it drops at the boiler where it is joined below the water line to a header attached to the opposite side of the boiler. There are five 2-inch risers attached to this dry circuit of pipe; these risers have spring pieces about 2½ to 3 feet in length connecting the risers to the main steam supply pipe. The grade of the connecting pipe is upward from the steam main pipe to the base of the vertical risers; there are no relief pipes to carry condensation away from the bottom of the vertical steam risers. The risers are taken from the main pipe at the following distances: from the steam boiler, 18 feet, 30 feet, 40 feet, 60 feet and 100 feet. There are four 1½-inch connections on this circuit, which supply four radiators on the first story, two of these are at the extreme end, 70 feet from the boiler, and two are about central between the boiler and the end of the building.

When the plant was tested it is reported to have worked perfectly at one-pound pressure, heating all radiation well, but at two pounds, gauge pressure, all water would leave the water glass. If the fire doors were opened, the water would instantly return to its proper level; this effect could be produced each time it was tried.

Some one suggested that the water was drawn from the boiler

into the return pipe, because the boiler pressure could not be maintained 190 feet from the steam supply if steam were admitted at the boiler end of the pipe and nowhere else. The result was an experiment. A 2-inch branch steam connection was placed in the return end of this loop of pipe, in other words the steam drum of the boiler and the nearest point on the return pipes were so connected that the steam was admitted at boiler pressure to the farthest point on the return pipe. This was intended to break any vacuum in the circuit and thus prevent water from the boiler rising into the return pipe and filling the circuit of pipes. The result was disappointing, water was lost in the water gauge just as before.

The boiler expert now took a hand. He had the return pipe disconnected close to the boiler above the water line; this was done on three occasions and never caused more than three gallons of water to appear at the point where disconnected. There were valves and flange unions on the mains near the boiler. They could thus be opened readily. Several experts were now called in. It was suggested to cut the main return at a distance of 65 feet from the boiler and drop the main return below the water line from that point to its junction with the boiler. This was done, but the results were not satisfactory. The water still leaves the gauge glass, the plant burns an unusual amount of coal; in moderate weather a ton of anthracite coal lasts six days; in cold weather it lasts three days.

The party who installed the plant makes the following replies to questions asked:

Used check valves on the return as an experiment; but as they did no good they were discarded.

Draft was too strong in flue, had to close damper in flue about one quarter of its area: flue was 12x16 inches, 60 feet high, brick construction with good draught.

No water showed at air valves.

Anthracite coal, stove size, was used.

Angle valves were used at radiators to control steam supply.

Radiators were three column vertical sectional and wall pattern.

All one pipe work.

Air valves were on the opposite end of each radiator from point of steam admission.

The water column on the boiler had connection from the steam drum and from the bottom of the boiler section; in other words, the water column was connected to the top and the bottom of the boiler.

The plant now runs up to 6 lbs. gauge pressure before water will leave the glass. This advance in pressure was caused by placing a section of the return pipe below the water line of the boiler and thus making that portion a wet return. This installation is not intended to represent a model heating plant and is here described because of its interesting peculiarities when in action.

When the plant was installed it was discovered that by shutting the pipe circuit which supplies the three-story wing of the building, the four-story end being in operation, it was possible to run the plant to three pounds gauge pressure before losing the water from the water glass, but on opening the circuit to supply the three-story wing, one pound gauge pressure was all that could be carried without loss of water from the glass. Another peculiarity of this plant is that one gauge of water must be admitted every other day, yet all pipes are in plain sight and there are no leaks, either from the pipes or from the automatic air valves.

Pressure to the extent of three pounds by the gauge is maintained on the plant night and day continuously, while the plant is in use; this is done at the suggestion of the boiler representative who inspected the plant. If the gauge pressure is reduced below three pounds, the water rises in the gauge glass and floods the steam space of the boiler. The party that installed the plant thinks the trouble lies chiefly in the over-rating of the boiler, as the same size boiler in 1898 was rated at 1,400 square feet; in 1900 it was rated at 1,600 square feet, and in 1902 it was rated at 1,750 square feet.

Many of the boiler manufacturers have raised the ratings of their boilers to such an extent in recent years that a conservative engineer will not place these boilers at their present ratings or within two sizes of their ratings, if he desires efficient service from the plant which he installs.

## DISCUSSION.

Mr. Dean: Mr. Chairman, I was called in at one time in Norwich, Conn., by a steam fitter, who told me he had trouble

with his piping and asked me to go with him and look at the job. I did so. The boiler was not fired when we arrived. We had the steam fitters who were working there fire up, and at about a pound pressure the water went out of the glass as quick as you could snap your finger. He called to the men to dump the fire. I said, "No, let it alone. The water is in the boiler." He said, "It is not; it has gone out." The boiler was connected exactly like the one shown in the paper; the bottom of the water column connected into the side of the front section, perhaps six inches higher than shown here, but into the centre of the section; and from the way it acted I assumed that the circulation in the boiler formed a siphon which pulled the water out of the glass. I suggested some changes, which were made. There was a header along the boiler at the side, the same as is shown in this boiler. I suggested that he disconnect the water column from the section and connect it to the header and that would improve it materially. He had his men make the change and it did improve it enough so that they could use the boiler after that without any other changes, and from that I assume that I was right and that the water did not leave the boiler, but simply left the glass and was siphoned out of the glass by the internal circulation in that front section. I think that is the trouble with this one here.

Mr. H. A. Smith: I would ask whether you would not consider it good practice in a case of this kind to have a wet return for a sectional steam boiler. Do not the gentlemen here commonly find that they are so defective in water capacity that it is a great help to have a portion of their returns wet returns to give an adequate water supply?

I would also like to ask any gentleman more experienced in this thing than I am, which includes all of you, whether to your minds there is anything in this description that bears out the author's conclusion that the defective working of this apparatus is due to an overrating of boiler? I do not see it.

Mr. Dean: I do not remember just the rating that the boiler had at Norwich, Conn., but I think the rating would have nothing to do with it. As I remember, the boiler would carry in the neighborhood of 800 or 900 sq. ft. of radiation. At the time the test was made to which I have referred, I do not think

there was 200 ft. on. It is not a question of carrying the rating, but it is a question of the circulation in the boiler.

I might answer Mr. Smith, too, in reference to the wet return. I believe that a boiler should be built so as to carry the proper amount of water, and if it does not carry the proper amount of water, I believe it ought not to be used, and personally I am very much in favor of a dry return. I have seen so many cases where returns have been underground that waste so much radiation, that personally I prefer the dry return.

Mr. Smith: Could I ask Mr. Dean why there is any more waste of radiation from a wet return containing water of condensation than there is from a dry return containing steam?

Mr. Dean: From my experience the dry returns are overhead and are generally covered—at least, where they can be covered conveniently; and the wet returns are often run underneath the ground, where they are simply buried. It is a practice that ought not to be done, but it is done.

Mr. Smith: I do not believe it is good practice.

Mr. Kent: Mr. Dean's suggestion that the water simply left the gauge glass and did not leave the boiler is a very important one, and I hope he will furnish a diagram to the secretary, explaining just how this could happen. If it is the case that the water not only disappeared in the glass, but also went down in the boiler, then I have a theory to bring forward on which I would like to ask the criticism of the members. Suppose we have a boiler here and the water is at this line (referring to a sketch), if we have a wet return the water should stand in the vertical riser at the same height as the boiler level, provided the pressure on top of the water in the boiler is the same as the pressure in the wet return. If we have considerable condensation of steam in the coils, there must be a flow of steam towards them, and the pressure in the back end over the wet return will be less than the pressure over the boiler, and consequently the water will rise in this wet return to a greater height, and the water in the boiler line will fall. I think that is the cause of the water being driven out of the boiler. A remedy for that would be either to abolish the wet return, or to establish a straight connection from the steam space right over to the steam space above the wet return, so

that this pressure could be equalized, and push the water down to the same level that is in the boiler. I offer that as a suggestion for criticism.

Mr. Allen: Would there not be the same condensation in your connection?

Mr. Kent: In regard to the condensation in the small pipe, it would be a small pipe and well felted and there should not be any great difference in pressure between one end of the pipe and the other, because it has no steam to carry except its own condensation.

Mr. Smith: In other words, that condensation of the pipe, as compared with the entire radiation of the system, would not amount to anything.

Mr. Kent: That is right.

Mr. Dean: I was looking in the paper to find the pressure at which he said it left the boiler. If I remember correctly it is one pound. That would only throw it up in the return pipe about two feet. Of course, if I remmeber correctly too, the return there was about four feet above the boiler. But I would say that it is absolutely necessary that the pressure be equalized. I had a case of where two boilers were connected together—a four-inch pipe from either one; one was with an angle valve and the other with a globe valve, and when those boilers were being fired very hard, the difference in the friction between the two boilers would make the water-line drop in one boiler and go up in the other, because of the difference caused by pressure in the difference in the opening between the angle valve and the globe valve. To remedy that, an equalizing pipe two inches in diameter was run direct from one boiler to the other boiler, and after that the water-line was always maintained the same in both boilers with no trouble.

Mr. Smith: How were those boilers connected into the common header?

Mr. Dean: By a four-inch pipe out of the top of either boiler. Suppose we are facing the boilers; from one boiler there was a pipe about four feet long, from the angle valve into the header, running off to the right. From the other the pipe went straight back into the globe valve; from that, back into a large main which turned to the right and then came forward and joined where the other pipe on the other boiler came in.

Mr. Kent: Was there a wet return to both boilers?

Mr. Dean: Yes and no. It was a single pipe system, but about fifteen or eighteen feet of that was a wet return; came back in a common pipe and then distributed to the two boilers.

Mr. Smith: I had in Duluth a battery of six good-sized boilers connected approximately as you describe. We tried every kind of expedient. We finally remedied the difficulty, which was entirely unequal water-line in the various boliers; they were never equal, they were never the same, they were constantly changing and drifting with every change in the draft and damper. We took the flow pipe straight up, carried it over with a goose-neck down and came down into the top of the common header. That made a very beautiful piece of work. They went very fine after that.

Mr. Kent: Mr. Dean suggests that this trouble happened when there was only one-pound pressure in the boiler, which would only equal a little over two feet of water column and would not be enough to depress the water level very much; but it is quite possible there might be a partial vacuum in the reurn pipe which would make the difference in pressure a good deal more than one pound.

Mr. Smith: Speaking of that, I had this kind of experience one time on a boiler in St. Louis where it was impossible to raise the pressure practically at all. Our trouble, as I recall, first began at about two pounds, but the instant you raised the pressure above about two pounds the water left the glass. I went down there and lived with that job for two or three days, and one of the things that I did was to put a stick on top of the safety valve up against the ceiling so that the safety valve did not work any more. This was in a fire-engine house. When I did that the firemen all went out and stood on the curbstone on the other side of the street. I got the pressure up to twelve pounds and took my stick out and I could hold the pressure there very nicely. It would stay there as long as I kept my fire good for twelve pounds. You could not raise the pressure at all without driving the water all out of the boiler. It was a very sensitive boiler and had pretty nearly a complete dry return system, and easily drove all of the water out of the boiler when you were raising the pressure. Having the pressure raised, it stayed there very uniformly. In that case the

operation of the thing was extraordinary. I have played with the damper chains. When I opened the draft door and closed the check draft the water left the boiler as quickly as Mr. Crane's canoe will respond to the movement of his rudder cords, and the reverse; but having pressure up to a high point or at any point—six pounds, four pounds, anywhere, it stayed there. The trouble was all in raising the pressure. I am wondering if that was not perhaps true in this case.

I also want to say in regard to Mr. Gormly's general conclusions that I think it is possible that some heating contractors are worried over the advance in ratings of the boiler manufacturers. I think that every boiler manufacturer has recognized for a long time that his ratings have been considerably lower than necessary, and while it is possible that some of them may in one or two recent advances have got beyond the line, I do not believe that this incident, at all events, shows that they generally have, or that this particular boiler has.

Mr. Dean: I want to say one more word to make myself fully understood. In a general way the cause of the water leaving the boiler, in my experience, in nine cases out of ten, has been because the steam main was not large enough to carry the steam to supply the radiators and equalize the pressure at the far end of the main, and thus, as Mr. Kent suggests, held down the pressure in the return. On account of the main being a little small there was not the pressure at the far end, and of course the pressure on the water in the boiler would back the water out from the boiler. That has been the case nine times out of ten. But I believe in this particular case, from the looks of the boiler, that it is siphoning the water column.

Mr. Smith: That is quite true. In other words, I think, Mr. Dean, the friction created by the small pipe is added to the pressure on top of your liberating surface and works back against the return.

Mr. Chew: On page 6, about the middle of the page, the paper says: "Another peculiarity of this plant is that one gauge of water must be admitted every other day, yet all pipes are in plain sight and there are no leaks, either from the pipes or from the automatic air valves." One of the gentlemen here

asked some explanation of that peculiar thing and just what is meant by that.

Mr. Smith: What is a gauge of water?

Secretary Mackay: As I take it there are three gauge cocks on that boiler. It seems to be necessary to introduce one gauge, which was the volume of water between the first and second cocks, every day. It seems that it evaporated or made away with that amount of water every day. There is another point on the same page where it says: "When the plant was installed it was discovered that by shutting the pipe circuit which supplies the three story wing of the building, the four story end being in operation, it was possible to run the plant to three pounds gauge pressure before losing the water from the water glass, but on opening the circuit to supply the three story wing, one pound gauge pressure was all that could be carried without loss of water from the glass." From that it would seem to me that there was a lack of capacity in the boiler to supply the amount of radiation which was connected to it, and that a vacuum in the balance of the system lifted the water which would otherwise show in the glass. The gauges which he refers to in the paper are the gauges of water on the boiler, and of course in common practice when there are three gauges on a boiler, one is supposed to be steam, two are supposed to be water. If the middle one shows steam they are supposed to add water until it shows water.

Mr. Kent: In regard to this statement about leaks I think it could be made all right if it said: "All pipes are in plain sight and there are no *apparent* leaks." A total leak of one gauge in two days is an extremely small quantity. I have made a rough calculation here showing it would be about two and a half pounds of water an hour and that amount of water could escape per hour without anybody knowing it. I think the drop of water in the boiler is simply a measure of the leak. Although you were not able to determine the leak anywhere else there might have been a leak through the blow-off valve for that amount.

Secretary Mackay: If it was a leak I think it was an evaporation through the air valves, the apparatus working between a pressure and a vacuum.

Mr. Kent: That may be. There are very few blow-off valves that are tight. They drip a lot of water.

Mr. Cobey: This discussion of the boiler and the water leaving it brings to my mind an experience I had the winter before last. I put in a boiler for a friend of mine and he was very anxious that I should make it as cheap as possible, and in doing so he decided on having a 500 volt rotary generator, and we put on about 550 feet of radiator surface. He explained to me, very logically, that he could shut off his nursery while he was running his sleeping apartments, etc., and keep within the limit. Along the last of it he made up his mind he would do away with the coverings of the pipe throughout the basement as it would heat the main construction of his residence. About midwinter he was very dissatisfied with the boiler, as the water used to leave in a way similar to that described in this paper, and he condemned the system in terms that I would not want to repeat here. I told him I thought if he would have the pipes covered it would remedy the defect, and that I would cover the pipes myself and if it was not satisfactory I would not charge him anything for it, and then I would go on and take out the whole of it. I sent to New York and got the pipe covering and covered it, and he has operated the boiler at six pounds pressure ever since in weather down as low as zero, and he has had no trouble with the water leaving the boiler. So I think that this trouble to a great degree is more or less caused by overdrawing the capacity of the generator. We find that especially so in large plants where the systems are trapped. Where you get any considerable number of traps discharging at the same time there is a tendency to raise the water in the boilers, especially if the boilers are not equal to the task that is put upon them. I have reason to believe from all the experience I have had that there is more or less trouble caused by overloading our boilers.

Mr. Ashworth: This discussion has been exceedingly interesting to me, although I am not a representative of the steam-heating expert line. The points that have been brought up afford thought for the finer details connected with such a problem and the possibility of producing such a result, but after all I firmly believe that if the boilers had ample capacity we would not have to grapple with such a mysterious problem. This is one of those cases which afford great opportunity for running

after a mysterious current and creating in the brain, as it were, one of those profound mysteries in which we should all become involved to a certain extent, and I tell you, gentlemen, the root of this whole affair and a multitude of others which gentlemen have ascribed to some mysterious agency has been produced by a lack of proper boiler capacity, and it is well that we should look after that. Our position here to-day is to advocate broad, ample capacity, and then we will not have these troubles.

Mr. Smith: I should say, on general principles, that a lack of capacity is something that does not require control. Excessive capacity might perhaps. I do not agree with what would seem to be the point of Mr. Ashworth's claim, that it is the best policy to install the boiler so large that it will force its way through and against all kinds of mechanical defects in the construction of the system. I do not believe that is good policy. It makes you pay for a boiler that you do not need.

Mr. Kent: I do not agree at all with Mr. Ashworth. The defect of lack of capacity of a boiler ought to be shown in two places—first, that it does not heat the building or section, and second, that it requires too much hard driving in the grate, too much coal. These two errors are enough for a boiler to be charged with. If it is of too small capacity it will burn too much coal; that is, you have to carry too high a temperature in the flue gases or it will not heat the building. It ought not to be charged with all the defects of the apparatus. If you put in a boiler of ample capacity for heating a building in ordinary conditions, the boiler is bound to be of too small capacity when you are starting a fire in a cold building. You will always find that trouble. But the troubles shown by that boiler could be simply those due to not heating the building fast enough and burning too much coal, and they ought not to show any troubles with regard to water levels and the escape of the water from the boiler. These troubles mentioned in the paper are entirely due to some defect in the piping system and should not be charged to the boiler.

Mr. Galloup: I have a suggestion to make on the subject under discussion; I am of opinion that the water stayed in the boiler unless it took a turn similar to a job that I installed once where the water went up the main riser out of the top of the

boiler, twelve feet, on four to six pounds of pressure. When we got it about four pounds, it would go over the top to that height. So I offer that as a suggestion, that it is possible that the water went over the steam main by priming.

Mr. Kent: I had a similar case at one time of the water leaving the boiler. There was one pound pressure in the boiler, but the water rose some four or five feet, and filled a radiator which was perhaps 60 feet away, and four or five feet above the water level in the boiler, so that when the air valve on the radiator, which was placed at about two-thirds of the height of the radiator, was open, water escaped out of this valve, showing that the radiator had been filled with water which had been driven in there apparently to fill a vacuum. It seems that after blowing the air out of the radiator then the steam condensed in it and formed a vacuum. After we put more water into the boiler things got a little warmer, then that water all came back and the boiler was flooded. There was a defect in the piping system, no doubt. The trouble in that case disappeared after we had felted the mains and returns. The main itself condensed a great deal of steam and increased the amount of work of the boiler, the cellar and the building being cold, and there was a great deal of condensation, an extraordinary amount of work was thrown on the boiler, and we had all these troubles which are mentioned in the paper; but after the pipes got covered and the building got warm, the trouble disappeared.

Mr. Galloup: I would like to add, in connection with what I said, after cleaning the boiler four or five times thoroughly, the priming was overcome. It was due entirely to peculiar salts in the water.

Mr. Smith: Of course that is the commonest cause perhaps of the water leaving a new boiler. If you have got a scum of oil coming from your pipe fittings and connections that forms a coating over the top of the water where your liberating surface should be, the boiler will be likely to prime.

Mr. Thompson: I do not know, and I do not believe any single man knows, all the reasons for water leaving the glass in a boiler. I know some of them. You probably have noticed the small, round house-heating boilers that are being sold to-day. I think there is scarcely one but has the return

end of the water column connected just below the water line. A few years ago that was not done so. It was connected down at the bottom. Some years ago I had quite a little trouble. I had a boy working for me who said he believed it was caused by the draft of the water. His idea was that when the fire was running strong and the water was severely agitated, that it would run up through the leg of the boiler from the bottom to the dome and that it made a suction, a suction of water out of the glass. The boy was absolutely correct. I sprung that on quite a few people. I remember not very long ago, where there were a few gentlemen who were very much interested in the boiler business, large manufacturers, and they would not believe it. I said I would prove it to them. We took a boiler, the return end of the column was connected into the dome just below the water line. That would work all right. You could run up to five pounds of steam, and the water would rise a little at first and then it depressed a little, but would not go out of the glass. I took a thirty-inch glass and started that glass on the opposite side of the boiler and dropped it down so that it was thirty inches lower than the other; it was nearly down to the return of the boiler, and those openings were taken out of the same connection on top of the dome. Just as soon as two pounds of steam was raised, the water in the thirty-inch glass was twenty-six inches less than it was in the other. If that proves anything it proves conclusively that the water did not go out of the boiler. Besides that, we have frequently tapped the boiler and put in little pet cocks where the water should be, and would find the water there. Now I found another case, I found that with a boiler connected up it may do two things: Sometimes the water will leave the glass and at the same time it will carry water up into the main; that is, it is carried up in the form of a spray, and is thrown against the side of the pipe and carried by the velocity of the steam into the radiator perhaps away up on the third floor. I found that was due to the fact that the openings are too small. We will suppose a boiler connected with a three-inch main, if you will, and one three-inch main opening out of it. You start that boiler up and run it up to two or three pounds pressure, and then you begin to find the water in the pipes. If you break the L and put on a T and carry it over and connect up

another three-inch main into the same main; that is, have the the one steam main, but two three-inch connections into it, in most of the cases it will stop the water leaving the boiler, because it reduces the velocity of the flow of the steam out of the steam head to one-half. I know that, because there are three very bad cases where boilers have been run through a winter and they had got along in some way, but they were in such bad shape they were going to be taken out and special devices put on. I suggested that they try this first. They laughed at me. Two of the boilers carried the water up into the radiators; but it all left the glass just as soon as the pressure would rise. In that case they were all connected with one three-inch main. We broke the elbow, put on a T and got the whole three boilers up, and they worked perfectly.

The President: I was going to ask you—was that boiler one of the type of the Ideal or had it a drum?

Mr. Thompson: No; it was on the type of the push nipple boiler. That is, the steam dome was self-contained in the boiler; there was no header as in the case of the other boiler. It was impossible under any pressure to drive the water out of the glass, nor was there any wet steam. But I am not going to say that what will occur in one case will occur in another. I know that in many cases of heating if you would take more openings out of the steam head of the steam boiler you would get better results and would also relieve this trouble of the water being sucked out of the glass. When the main is submerged, it gives the water a chance to cool; the water comes back to the boiler at a little cooler temperature and it prevents this apparent rise of water through the sections of the boiler up the water leg. Something has been said about the boiler being over-rated or over-loaded, but I think there is a great deal of truth in the fact that when you open the fire door, if the water is out of the glass, it will go back immediately. That shows that water has not gone out of the boiler. It simply stops that rise because the boiler cools down and the water stops rising. When there is a submerged return, the moment you do that the water comes back very slowly and it must be of necessity cooler when it enters the boiler. I believe when a submerged return is put in, the water in it gradually cools

down, and when it comes to the boiler it keeps the water from violent ebullition.

There are one or two things I do not understand here. I do not understand that if the gauge pressure is reduced below three pounds the water rises in the gauge glass. I never saw that. As soon as the pressure begins to rise I have seen it begin to run out, and that is caused by want of circulation in the boiler. I am satisfied that a great deal of trouble is caused by want of circulation. You can take either a square boiler or round boiler, and unless you put a very large, wide water leg, it must of necessity cause a rising of the water; where is there room for the water to come back?

About the loss of water, I would say, answering Mr. Kent, that I think both he and Mr. Mackay are right in a sense. I have seen it occur in the boiler itself; may be find it out a year afterward where there is a leak that is really invisible. The leak might be up in the crown sheet where you could not see it, and you can understand, if there is a little fine drip, or two or three of them, say some of the nipples are leaking—they never drop at all, but the intense heat of the fire just keeps them evaporated.

Mr. Roys: I had an experience something like that described in the paper, and the way I cured it was by dropping the water line. In other words, there did not seem to be enough steam chamber, and the water was carried up into the radiators. So I simply dropped my water line about six inches and cured the trouble I had. When we got one, two or three pounds pressure, the water would leave the boiler and go up into the glass.

Secretary Mackay: I would like to call attention to the fact that on page 1 of the paper the writer says: "The entire plant contains 1,370 sq. feet of direct cast iron steam radiation. The mains and branches are not covered by non-conducting material. The boiler used has a grate 27 by 54 inches, or 10½ sq. ft. of grate surface; 198 sq. ft. of fire surface; height of water from floor, 57 inches; top of steam drum from floor line, 80 inches; all measurements taken from maker's catalogue. The boiler is vertical, cast iron, sectional, rated at 1,775 sq. ft. direct steam radiation." That of course includes the surface of the mains. If you add to the actual radiating surface 1,370 sq. ft., say 20 per cent., which is a nominal amount, not an

excessive amount, you get 1,644 sq. ft. of surface, while by the most excessive rating of the manufacturers the boiler would carry 1,750 feet. I think that that explains the whole matter. The boiler was possibly properly rated in their first rating of 1,400 sq. ft. In substantiation of the fact that it was over-rated or was asked to do more work than it would do, when they shut off a certain portion of the building, the remaining portions worked satisfactorily. It would seem that the boiler was merely over-rated or over-estimated, and asked to do more than its grate area and fire and flue surface would allow it to do.

Mr. Dean: A number have spoken about driving the boiler and forcing the water out. Now, is it possible to drive a horizontal tubular boiler to force the water out? Is it because, as Mr. Thompson suggests, that the boilers are not built so as to circulate properly, and because they do not have the proper circulation that the least little extra exertion on them causes them to throw the water out? I think that is a subject for us to think of in connection with this.

Secretary Mackay: My experience is that when a boiler is working between a pressure in the boiler and a vacuum on the system the water will leave the boiler, and when you have sufficient capacity in your boiler to maintain a steam pressure in your radiation and maintain your water line, it will not do it. The wet return merely helps out a boiler that has not sufficient water capacity.

Mr. Kent: How can you drive water out of a boiler that has a return discharge into the steam space?

Secretary Mackay: The condensation of the steam is held in the radiators by the vacuum in the radiators.

Mr. Kent: If it has a free path back into the boiler its gravity will carry the water back into the steam space.

Secretary Mackay: When you maintain a steam pressure in the radiators the water will return to the boiler.

Mr. Roys: How can you have pressure and a vacuum at the same time? I cannot quite see that.

Secretary Mackay: The boiler generates the pressure; the radiator maintains a vacuum. As it condenses, if it does not get steam pressure from the boiler it acts the same as a pump holding water in the radiator.

I have no doubt but that others have had the same exper-

ience—that it was impossible to maintain a slight pressure on the boiler, and that the radiators being a certain distance from the boiler did not have that same pressure, and there was a partial vacuum on the radiators, sucking up water instead of maintaining a uniform water line.

Mr. Cobey: As I understand this pressure and vacuum, as soon as the boiler furnishes pressure enough to discharge the vacuum, the water returns to the boiler voluntarily. That is the sense of what you said, is it not?

Secretary Mackay: That is right; but if the boiler is not able to maintain sufficient steam to upset that vacuum, the vacuum exists in the radiators although you may have a slight pressure in the boiler.

President Crane: I had a job in a schoolhouse that acted very much in this manner; I will give you a description of the character of the work so that you can understand more fully and the remedy applied. The main part of the school, the rooms, were heated with cast iron wall radiators arranged with a feed and return. The hallways were supplied with ordinary vertical sectional radiators connected on a one-pipe basement circuit. That portion of the job which required a feed and return was piped separately. The main supplying the coils was relieved through seals at the base of each riser. The returns for this part of the system were overhead, with the return risers sealed before connecting to the same; conditions made it preferable to run these returns on the basement ceiling. Both the return system from the coils and the one-pipe circuit were run above the water line to the back of the boiler when they dropped down into the boiler headers. At a point above the water line and when they dropped into the headers, one-quarter air vents were placed. The circuit that connected the radiators (which was the one-pipe circuit) blew water constantly. I would further explain that both of these circuits were brought back on the same level, and while the one-pipe circuit air valve threw water, that of the coil circuit was dry; all the radiators and coils were free from water and in every way performed their functions. The water in the boiler would very gradually depart from it, requiring frequent replenishing, and all of it would return at night and flood the boiler. I will not detain you to tell you of the many

remedies we applied in our effort to get that apparatus to work, that is to get the boiler so that it would maintain its line of water. The trouble occurred after three or four pounds of steam pressure was secured, when the water would leave, and we applied check valves as a remedy. This resulted in the flooding of the returns, occasioned no doubt by the weight of the gates raising the water line into the mains. We were working on a limited water line of perhaps not to exceed 18 inches. Many were the things we did to remedy the evil; but we never corrected it until we replaced the boiler with another of the same make but of a larger size. The troubles ended and the job fulfilled all its guarantees, and I concluded that the boiler was overrated, for I am convinced that nothing we did contributed to its success except furnishing a larger boiler.

Mr. Dean: I would like to ask how many square feet of radiation there was on the job, and the size of the flow pipe?

President Crane: I could not answer that question here without the data, and my memory is deficient in that this job was erected four years ago. I remember, however, that we secured a circulation on less than one pound pressure, and that the water from condensation returned promptly at all pressures on the boiler; the water line was steadily maintained and the air vents on the returns were free from water, all of which convinced me that the pipe sizes were correct.

Mr. Harvey: Where you put in the new boiler did you change the piping?

President Crane: Not in any way; except to provide for the larger boiler.

## CXV.

# THE SCIENTIFIC BASIS AND COMMERCIAL FEASIBILITY OF HEAT RADIATORS USING AIR INSTEAD OF WATER OR STEAM.

BY GEO. M. AYLSWORTH, M.D., COLLINGWOOD, CANADA.

(Non-member of the Society; Presented by request at Semi-Annual Meeting, Niagara Falls, N. Y., 1903.)

In the past many have thought that air could be used in radiators instead of water for the distribution of heat, and about twenty years ago a United States patent was issued covering the point.

The scheme, however, proved a complete failure owing to the radiator being simply a square box many times the capacity of the conducting pipes. The current of air was so rapid that it passed through this box radiator in a straight line and an enormously large proportion of the air in the box was not changed in temperature at all. As a consequence the hot air parted with but a small percentage of its heat, while passing through this box form of radiator. The general appearance and construction of the radiator is shown in Figure 1. The scientific reasons for the adoption of its peculiar form and the use of thin sheet metal in its construction are as follows:

The conditions requiring to be met were a distributing agent that would make the circuit of the furnace and radiators many times while water was making a similar circuit once. At the same time, the rapidly moving air would absorb much less heat from the furnace, bulk for bulk, than the slower moving water.

The problem therefore was to evolve a radiator that would compel the air passing through it to part with all or nearly all of its heat to the air of a room without diminishing the rapidity of the travel of the confined air.

The problem has been solved by the adoption of four devices.

First, By increasing the distance the air has to travel within a short space.

This was accomplished by the up and down or to and fro course the air is compelled to take in passing through the radiator. The distance from the centre of the inflow pipe to the centre of the outflow pipe is 2 feet, while the air travels in the radiator four and a half times as far, or an average of 9 feet.

Second, By offering the least possible obstruction to the passage of the heat from the air within the radiator to the air outside the radiator, but within the room.

This was accomplished by using sheet metal as thin as is consistent with rigidity.

FIG. 1.

Third, By compelling the volume of air to spread out into thin sheets so that all of it, while passing through a radiator, should be kept as nearly as possible in contact with the enclosing metal.

This is accomplished by having the conduit through each section of the radiator, 1 x 7 inches rectangular in form, instead of round or square. The method of piping consists in having the area of the conducting pipe equal to the areas of the conduit or conduits in the radiator or radiators served by it. Also in having the volume of air necessary to serve a radiator, whether it have one or more sections, conveyed to the radiator in a single round or square column.

It will be noted that this method causes the difference be-

tween the circumference of the supply pipe and the conduits in the radiator to increase with each section that is added to it. The conduit in a single section has nearly double the circumference of its round supply pipe, while the conduits in a four-section radiator have three and one-half times the circumference of its round supply pipe.

The conducting pipes of a single section are round 3-inch pipes having a circumference of 9 inches and an area of 7 square inches, while the conduit through the section has a circum-

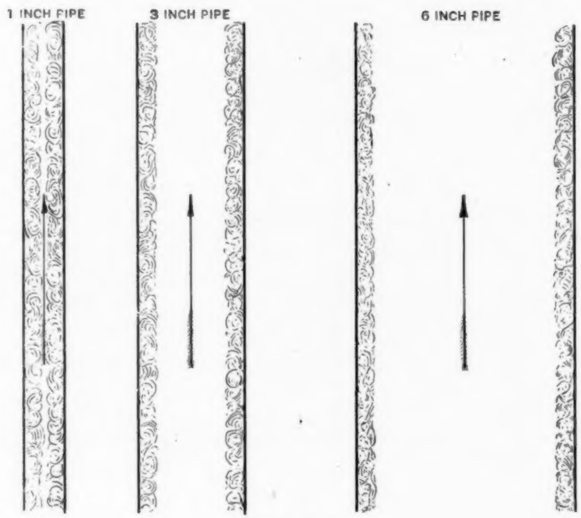


FIG. 2.

ference of 16 inches and an area of 7 square inches, or the same area as its supply pipe.

A four-section radiator is served by a 6-inch round conducting pipe, having a circumference of 18 inches and an area of 28 square inches, while the sum of the circumferences of the four conduits is 64 inches and the sum of their areas is 28 square inches, or the same as their 6-inch conducting pipes.

The extremely flat shape of the conduit through a radiator also prevents any part of the air it contains getting more than half an inch from the enclosing metal, while the centre of the air current through a 3-inch round pipe is 1½ inches away from the containing metal or three times the distance, and in a 6-inch

round pipe, 3 inches or six times as far from the metal, and so with each change in the number of the sections in a radiator.

It is a well-known fact, which can be confirmed by observation of any stream of water, that fluid in contact with the wall of a pipe, on account of the friction, takes on a revolving motion while passing through it, but the whole area of the current does not partake of this revolving motion unless the pipe is extremely small. The part of the area of the current that is un-


FIG. 3.

affected by this motion increases in proportion to the whole area of the pipe, provided the rapidity of the current remains the same. (See cut). This fact in connection with the other facts—that air cannot possibly get more than one-half inch from the confining metal when passing through one of these radiators, and can get from three to six times that distance from the metal in the pipes conducting the air to them—suggests the vast importance of the flattened conduit through the radiator.

Fourth, By facilitating convection; by which method, in

order to heat a room, all the air in it must be repeatedly brought into contact with the outside surface of the metal in the radiator.

This is accomplished by the flat form of the sections, and where there is more than one section in a radiator, placing them side by side with nothing to obstruct the flow of air between them from below upwards, as heat is imparted to it from the hot air within the sections. The results obtained in the following experiments by the use of these radiators will be a surprise to those who have not studied the subject and they were a cause for astonishment to myself, their originator.

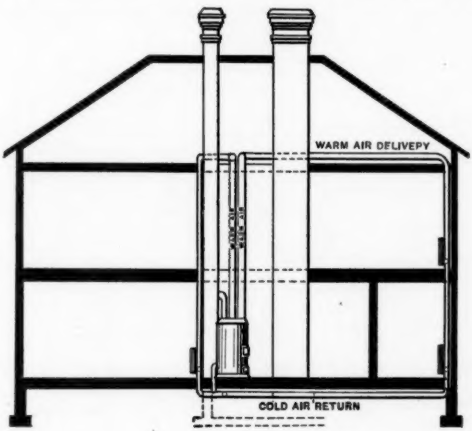


FIG. 4.

In Feb., 1902, I fitted up a house that was in process of erection with a discarded wood furnace and rough hand-made radiators. The house was isolated and consisted of a cellar, ground floor, first floor and attic, and contained on the ground floor and first floor, 18,000 cubic feet of space. The cellar had a foot of ice on its floor which was chopped away from the immediate neighborhood of the furnace. The house is now brick-clad, but at that time was neither lathed, plastered nor bricked, and had many openings, large and small, through the outside walls from the cellar to the attic as well as through the roof. Ten radiators were placed in position, nine on the ground and first floor and one in the attic. A number accepted my invitation to visit the house on the afternoons of

the 12th and 13th of the month. On the 12th, the outside temperature was 22 degrees Fahrenheit. On the 13th it was 12 degrees Fahrenheit, with moderate wind from the northwest. On each day all the radiators became warm within forty-five minutes after the fire was lighted. Two weeks later many of the openings had been covered with building paper preparatory to bricking the walls, the attic and cellar had been roughly shut off from the two floors, the house had been lathed with wet and frozen lath but not plastered;


FIG. 5.

the temperature was 18 degrees Fahrenheit, with moderate west wind. The ground floor was brought to 63 degrees Fahrenheit within two hours after the fire was lighted. These results are phenomenal when we remember the wet lath and the enormous difficulty of heating a building when the plaster is wet, as pointed out by Mr. John Gormly at meeting last winter, in a paper entitled, "A Time Limit and Dry Walls Necessary in Testing a Heating Plant." The radiator in the attic was 20 feet horizontally and 20 feet perpendicularly distant from the furnace; it was the last of five on its main—two others having been supplied from the same pipe on each of the lower floors. The air entered this radiator at a temperature of 213 degrees Fahrenheit, and left it at 122 degrees Fahrenheit. Some

of the heating experts present at this test believed, or at least said, while admitting the results, that the system would not stand a practical test of the many turns in the piping needed to place radiators at the points needed or preferred by house owners, nor would it succeed with the slower fire, as from anthracite coal.

To meet these objections, and having in the mean time had the radiators made in a presentable form, I fitted up my own house with them in 1903.

The house was an old-fashioned frame of two stories, the

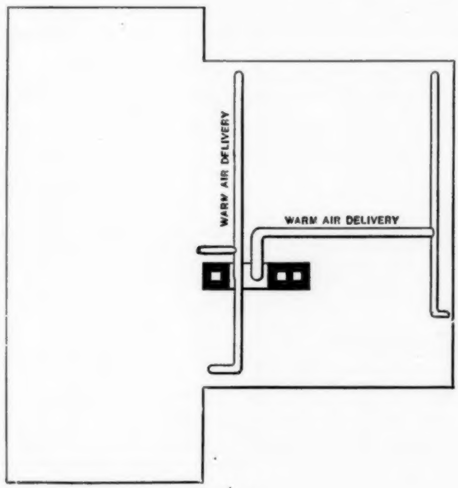


FIG. 6.

part served with radiators containing 17,000 cubic feet divided into ten rooms and two halls. There being no basement nor cellar, the furnace was set upon the ground floor and burned anthracite coal. It had never been repaired nor had its location been changed, although it had been in use for thirteen seasons. The ten radiators installed were supplied from three main pipes; two of these pipes conveyed the air through the attic before it reached any of the seven radiators; they served the ground and first floors; it was an overhead system, which it is hoped the accompanying plans will make clear.

The tinsmiths finished their work and a fire was lighted at 2 P.M. on the 19th of February. The next morning at 8 o'clock

the temperature outdoors was 6 degrees Fahrenheit, and in the house it varied from 44 degrees to 60 degrees. The house was never as cold again, and after the first few days the system was better balanced and the variation within the house seldom exceeded 10 degrees, and only once did it reach 16 degrees; when the temperature outdoors was about 11 degrees, with a gale blowing from the northwest, the temperature within varied from 54 degrees to 70 degrees.

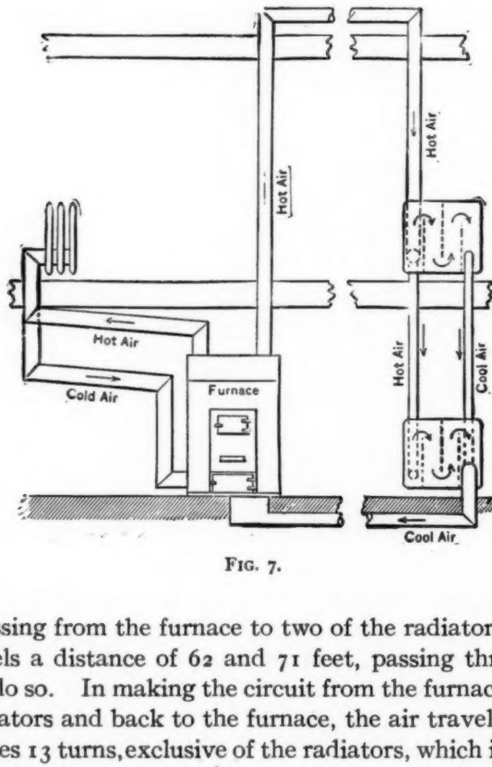


FIG. 7.

In passing from the furnace to two of the radiators, the hot air travels a distance of 62 and 71 feet, passing through the attic to do so. In making the circuit from the furnace to these two radiators and back to the furnace, the air travels 107 feet and makes 13 turns, exclusive of the radiators, which if counted would make the air travel 116 feet with 21 turns, showing conclusively that turns in the piping have little or no effect upon the flow of air when it is confined and used in this way, and demonstrating how easily any probable conditions in any medium-sized building can be met with this system.

The foregoing results are much better than could be ob-

tained with this furnace under the old system, for before the installation of the radiators it had been found necessary, in order to get the same comfort, to supplement the furnace with two stoves and a large drum on the first floor. The latter utilized the heat from the smoke pipe of the furnace and it and the two stoves were done away with after the radiators were put in. Over and above this a very large percentage of the heat generated by the furnace is wasted, while the hot air is passing through the pipes in the attic before reaching the radiators, for the large amount of piping in the attic kept it at a higher temperature, notwithstanding attempts at insulation, than either of the lower floors, which of course was not the case before the radiators were used.

As to the consumption of fuel, it is impossible to be exact in connection with these experiments, but the quantity consumed during the two and one-half months the radiators were used would indicate that the present arrangement will not require more than the old one has done.

One of the reasons for uncertainty in estimating the consumption of fuel, in addition to the removal of the two stoves and heating drum aforementioned, is its rapid diminution, as the best method of running the furnace under the changed conditions was learned—for instance, two tons of coal were consumed in the first 18 days, a third ton in 11 days, or (omitting fractions) a ton every 11 days. A fourth ton was burned in 23 days, and a fifth in 18 days, or a ton every 20 days. That is an average per day of twice as much burned during the first 29 days than was burned during the last 41 days, though the average was within a degree of being the same in each of the two periods with increased comfort during the latter. The rate at which the coal was consumed during the 41 days is almost identical with the rate of consumption in the past when registers were used.

The diameter of the fire pot in this instance is 18 inches, because the builders of the furnace claimed that that size pot was plenty large enough to heat 18,000 cubic feet. But this, as was not unusual in those days, was an overestimate, and at the present time it is unusual to find a reliable hot air furnace-maker making such a claim even when the familiar instructions—"Locate the furnace so that all hot air pipes shall be as

short as possible" and "Place registers as close as possible to the furnace" are closely followed.

In this test of hot air radiators these rules have been purposely violated, and the departure from them is so wide that it is believed that 50 per cent. of the heat from the furnace is lost in transmission to and through the attic.

It is not anticipated that any one in his senses will adopt such an overhead system except under compulsion, neither can it be expected that the results under the conditions of this test should be ideal, yet they are the basis of the confidence felt that the proper installation of these hot air radiators will demonstrate beyond all question, during the coming winter, a decided economy in the consumption of fuel through their use.

Secretary Mackay: Before going into the discussion of this paper, I would move that a vote of thanks be tendered to Dr. Aylsworth for his courtesy in presenting this paper to our Society.

The motion was seconded and carried.

Mr. Kent: I would like to ask a question in regard to a few lines here: "The rate at which the coal was consumed during the forty-one days is almost identical with the rate of consumption in the past when registers were used." What then is the advantage of the system?

Dr. Aylsworth: You apparently overlook the fact that a large proportion of that heat was wasted. In this arrangement I estimated that fifty per cent. was lost in passing through the attic. The steam heating people have a great many claims against the heating by hot air in the present system because the air has to pass over the furnace, and the advantage of this system is that you get the same conditions that you get with steam and hot water.

Mr. Kent: Does the air pass over the furnace in this system?

Dr. Aylsworth: It certainly passes over the furnace, but it does not pass into the room.

Mr. Switzer: Did you have any outside air supply at all?

Dr. Aylsworth: None whatever.

Mr. Switzer: You had no ventilation from any of the rooms, no exhaust ventilation through any ventilating shafts or ventilating registers?

Dr. Aylsworth: I would say that my house has a large ventilating shaft that was used in connection with the furnace, but there was no ventilation in connection with the air as it passed through this radiator.

Mr. Switzer: Does this (referring to a cut in the paper) represent a fireplace?

Dr. Aylsworth: No. There is a shaft passes between the two chimneys through the roof.

Mr. Switzer: Was that open at the bottom?

Dr. Aylsworth: That was open at the bottom and the top. You understand that the air that is used in heating the house does not pass through that shaft at all, except in passing in pipes to the radiators.

Mr. Switzer: No, but it created an exhaust?

Dr. Aylsworth: No. The air was not loose. It was confined to the radiator and the pipe.

Mr. Switzer: I have no reference to the air in the hot air pipes that come from the hot-air chamber of the furnace. I mean the general atmosphere of the house, of the rooms proper, whether there was any exhaust.

Dr. Aylsworth: There was an exhaust in this shaft that I speak of, a continual exhaust, and also two fireplaces on the ground floor.

Mr. Kent: I would like to ask how serious is the objection to having the air pass over the furnace in the usual way, and then be discharged into the room? That is the ordinary custom in the United States and I suppose elsewhere, and I understand there is very little objection unless there are leaks in the cast iron chamber.

Mr. Cobey: Mr. President, I can say from what experience I have had in heating, that there is more or less objection to burning out certain elements of the air before we breathe it, and in passing a current of air over hot plates and breathing it afterward; from a scientific or a hygienic standpoint I should think it would impair that quality of the air that is necessary for us to breathe. That is why I suppose this is looked upon as an improvement over the old hot air system.

Mr. Switzer: The action of the furnace is identically the same with this system as it would be with the ordinary systems of circulating cold air from a radiating chamber, so that

the particular feature is not to rarefy or purify the air, but to get increased radiation by circulating the air by the furnace through these radiators. The thought that would occur to me was in regard to the supply from these radiators to the cold air chamber passing through the furnace, would not that be diminished after a certain length of time? Did you notice any particular defect or depreciation in the amount of radiation from the radiator? It certainly is a novelty, Mr. President, this form of construction, well worthy of discussion, and reaches pretty deep, and I trust that some of our scientific members will give us all the light on the subject that is possible.

Mr. Roys: As I understand this system, it is the same as a hot water circulating system, using the hot air furnace instead of a hot water boiler, and the air passes through the radiators, circulating the same as it would with an ordinary hot water plant. The reason that I speak of that is that the first idea that occurred to me was that possibly he took the products of combustion and passed them through the radiators, but it is just the air passing over the furnace and circulating in the same manner as water in an ordinary hot water plant.

President Crane: I would call the members' attention to the fact that in this paper the author states that the temperature of the air passing into the radiator was 213 degrees Fahrenheit, while that of its exit was 122 degrees, or probably but a little bit higher than what you would get in hot water, which in a well balanced apparatus very seldom ever reaches much more than 180 at the radiator with a 15-degree diminution at the outlet, and I suppose that that is the claim of the paper—that the air in the room is passing over the surface very much less heated than it would be in a furnace, therefore not affecting the natural conditions of the air.

Mr. Kent: Mr. President, it strikes me that this is an exceedingly well designed system for the results which it accomplishes. The radiator is very efficient in reducing the temperature from 212 degrees to 123 degrees. It shows an excellent design of the radiator, and the piping system must be very well designed also in order not to have any short-circuiting of the currents of air, so that they pass equally through all the different parts of the system. He shows here two branches of the system, and I suppose in a larger house there would be

more branches. It would be necessary to proportion these pipes and the valves in them so as to make an equal obstruction through the whole system, so that the air would circulate equally through the whole system. The natural tendency of the air is to follow the path of least resistance, and it would follow that path and be circulated around through certain radiators and neglect others. In that respect, this particular design seems very well adapted to uniformity of circulation. I think some difficulties would be found in adapting it to larger houses in getting that uniformity, but the one advantage this system appears to have over the ordinary register system, as far as I can see, is that the air which passes over the furnace gets heated up to 400 or 500 degrees right at the furnace and 200 degrees when it goes to the radiator, does not get into the rooms at an equal degree. I do not see that the air is hurt by passing over surfaces of 300 or 400 degrees temperature, if the air is pure. It is only oxygen and nitrogen and you cannot hurt them by passing it over. But if the air is impure, having organic material or bacteria, you may cook the bacteria and have a bad smell from cooked animal matter. But I believe that is not found in practice to be any serious objection to the hot air system. The great disadvantage of Dr. Aylsworth's system seems to be that it does not ventilate. One of the advantages of the hot air system over steam radiation and hot water radiation is that the air from the furnace itself is a ventilator, and that is a very strong advantage in favor of hot air systems over radiating systems, and the radiating systems for good practice have to be combined with ventilating systems. You need to have the direct-indirect system or the indirect system for accomplishing the result of both heating and ventilation. This system has an excellent distribution of air. It carries the air down through cold air pipes. The same result would be effected if you adopted the system, simply left out the radiators, let the pipes be exactly as they are, and discharge that hot air into the room at the ceiling and take the cold air out at the floor; and it would be just the same with the difference that the air would be discharged into the room and the people would breathe it, and then it would go out of the room and be heated over again. One disadvantage of that would be the possibility of leaks to the air pot of the furnace and the

cooking of the animal matter. These are the disadvantages. The advantage would be the ventilation. You might balance these advantages and disadvantages against each other and see which would be the more serious.

Mr. Feldman: The only disadvantage in the ordinary hot air system is just the fact that the air passing over and over the heated furnace quite often has the dust contained in the air burned; that is quite very often smelled in very cold weather. That is one of the objects, I should judge, of this device to do away with the effect of getting heat in the room without getting this burnt dust in the air.

Mr. Roys: I can see another great advantage in this system and an advantage which appeals to me. In an ordinary heated house, with a hot air furnace, if the wind comes from the west your west rooms are cold; if it comes from the east, the east rooms are cold, because the pressure of the air will force the heat to the other side and also obstruct the heating of the rooms on the pressure side of the building. This obviates that, I should imagine, because the air circulates the same as hot water. The circulation is the same as it would be in a hot water boiler and is not affected by the winds.

Mr. Oldacre: I wish to say that in a properly heated house, heated by the warm air system, the west side of the house is no colder than the east side of the house, or else the house is not properly heated.

Mr. Allen: In Figure 4 the two circuits of pipe seem to be very unequal in length. Mr. Kent pointed out that it would have to be evenly balanced. I would like to know if those pipes are of the same size, the circuit going to the right and the short one to the left of the furnace?

Dr. Aylsworth: No; they are not the same size. The size of the pipe is governed by the amount of radiating surface you have in the radiator. It is governed entirely by the number of sections.

Mr. Oldacre: I would like to ask what is the method of proportioning the radiator surface to the size and exposure and cooling effect of the rooms?

Dr. Aylsworth: It is exactly the same as that of steam or hot water.

Mr. Switzer: Is there not some deterioration in the air pass-

ing over the radiating surfaces of the furnace, circulating through the system, returning to the cold air chamber and continuing to circulate? Now in all furnace construction the surfaces being highly heated from constant firing, the durable qualities of those surfaces are maintained by the radiation of the heat from the air supply coming in contact with the radiating surfaces, and if that air supply is not sufficient in quantity to absorb the heat from the fuel consumed, it will not be but a short time, in my judgment, when the sustaining quality, the construction of the apparatus, would be largely deteriorated; in other words, the life of the furnace would be very short unless there was a very substantial amount of air continually supplied to radiate the heat from these surfaces. In other words some forms of construction of furnaces become continually superheated and the life of them is exhausted in two to three to five years. With other forms of construction, and other installations and furnaces, they are extended twelve, fifteen and twenty years, and it has been found that the extended life of the radiating surface in furnaces where they are properly constructed and installed is largely governed by the amount of air supply passing over those surfaces and absorbing the heat that is radiated therefrom, and the question that I would like to ask the Doctor is: Did you notice whether there was any material deterioration in the supply of the air or in the volume after passing through the system, after say a week or ten days' or two weeks' use?

Dr. Aylsworth: I would make reply that nothing of the kind was noticed and I think we have had it stated here repeatedly this morning that the air undergoes no change whatever in passing over superheated surfaces.

Mr. Switzer: That was in reference to the hygienic quality of the air.

Dr. Aylsworth: You find the same conditions in heating by the ordinary system without any outdoor supply, fresh air supply, from outside.

Mr. Switzer: But the atmospheric pressure forces the air into the rooms continually. The object of putting these cold air return registers, as they are termed, into a cold room, is to draw the cold air out. Now this system does not adopt that form of ventilation. The ventilation here, I understand, is

through the fireplace and the flue openings. The pressure of the atmosphere into the exposed rooms of a furnace-heated house is so great that ventilation must of necessity be provided in order to have a uniform temperature, and it would seem that the atmospheric pressure would permeate into these rooms just the same with this system. But it is provided to be exhausted by these ventilating shafts. The furnace is not benefited by that.

Dr. Aylsworth: I think, sir, that you are in error in reference to the pressure from outside. The point, I think, that you are trying to make is that the air after being circulated for a length of time would lose its power of absorbing heat as it passed over the furnace and then to the radiator and back to the furnace, and the supposition that you are going upon is that the system is absolutely air-tight, is it not?

Mr. Switzer: Certainly.

Dr. Aylsworth: Well, it is not absolutely air-tight any more than furnaces are air-tight. They are very seldom air-tight. That is, the ordinary hot air furnace is not, as a rule, air-tight. If you turn it upside down and fill it with water you will find that there are a number of leaks in it. In practice the system was continued in use up to two months and a half, and in practice there was no loss of power.

Mr. Chew: I would like to ask a question that came up in my mind when I first heard of the Doctor's system. In the ordinary furnace system there seems to be a preservative effect through the cooling influence of the air passing over the surface continually. That air is never brought back partly warmed up, to destroy the fire-pot and the other internals of the furnace, as it is in this instance. As I say, there seems to be a preservative effect constantly from the cold air supply. In this we find that the air enters the radiators at 213 degrees, comes out at 122 degrees. It may go back into the furnace at 122 degrees. The furnace is constantly subjected to a hot blast and the hot blast is destructive, if it is sufficiently high in temperature. That is the point that came to my mind at once. If a man had a large house heated with air circulating fast enough to get back at a temperature say of 150 degrees, and the furnace subjected continually to a temperature of 150 degrees, how long would it last as compared with a furnace that

never got its air supply above 40 degrees? That is the question that comes in my mind—the durability of the apparatus. So far as the distribution of the air through the radiator, I must say that that was rather startling to me. But one vital point comes up, how long will the furnace last under such treatment? May be the Doctor has noticed in his own furnace what the effect has been in bringing that supply of air back constantly.

Secretary Mackay: The paper seems to be one that will stand a great deal of discussion and it is certainly a novelty in its line. Mr. Oldacre says it is possible to heat any building with hot air at all times satisfactorily, regardless of the outside winds. I think I can agree with him. But it is not always done; it is not done in ninety out of every hundred cases. One reason is that the furnace is too small for the building. The cold air supply is not sufficient to furnish the hot air pipes, anp as a result some of the hot air pipes on the cold side of the building act as a cold air supply. I found it in lots of cases that came under my observation. In this particular case the Doctor uses a furnace which he had formerly used for some twelve or thirteen years heating his building, and from his complaints I take it that there were times when some of those rooms were not satisfactorily heated. But he does heat the building more satisfactorily with his system now than he did when he had it used as an ordinary hot air furnace with hot air pipes to the rooms and radiators in the rooms, and the ventilation up to the ventilating flue or chimneys.

The point that Mr. Chew makes is one that comes up to me too, and that is the life of the furnace. I would like to find out from the Doctor if he has noticed any going to pieces of the furnace during the months that he has used it with this, as compared with the years of use with the other system?

Mr. Switzer asked—this being similar to a hot water supply —whether it would be possible for the heat to vitiate the air inside of the system? The Doctor answers that by stating that the system is not air tight, and that consequently it absorbs air from the room that it uses up in heating. Of course, if it were perfectly air-tight that could be arranged with an inlet check valve or an air valve that would admit air and not force it out. A hot water supply requires to be constantly replen-

ished. An air system under the same principle would require to be constantly replenished. It does not make any difference whether you pour the air in through a bucket or allow it to flow in or allow it to come in by a check valve, and the name of the valve would not help matters so long as it worked.

Mr. Smith: If your water system were submerged under water it would not have to be replenished.

Secretary Mackay: No, if there was an opening; but if it was a hermetically sealed one, as this is supposed to be, the water around it would not help it. He answers that question all right by stating that the apparatus, which it would be almost impossible to make air-tight, is not air-tight. If it did not get air from the rooms it would get air from the fire-pot of the furnace or some other point and suck it through.

The principal point that I would like to ask is this: He possibly had a certain cold air supply either from outdoors or from the rooms heated. That would be, if from outdoors, at the temperature of the outdoor air; if from the rooms, at the temperature of the air at the level at which it was drawn down. It might be 65 at the floor if it was 70 in the room. He brings it back possibly at 100. That is, it is less hot going to the radiator and going through the radiator, and we must suppose it lost heat going back to the furnace, and if it is 122 at a certain radiator 50 feet from the furnace, it must be less at the furnace.

Then the question comes to my mind, as he increased the volume of air from his radiators to his furnace over and above what he found necessary to supply this 18-inch fire-pot furnace, when he was taking it either from the room or from outdoors, of course you would not hurt your furnace any if you took a larger volume at a higher temperature sufficiently to take up your heat from the surface any more than you would if you had a small volume at a lower temperature. It seems to me that would overcome that. If you increase the temperature at which you take your air in and increase the volume of it, it would have the same effect in lengthening out the life of the furnace, as it would if you depended upon a lower temperature of the air and a smaller volume doing the same thing.

Mr. Cobey: Mr. President, I do not see where change in the molecular construction of the fire-pot could be any greater by feeding it with a blast at 120 degrees than it would to feed the

fire-pot with a blast at zero. It is more likely to disturb the iron by unequal contraction and expansion, and deteriorate the fire-pot or shorten the life of it fully as much as if it was fed with this mild blast which a man can always stand—he can live in 120 degrees temperature. I do not see where it would injure the iron any more than this very cold blast coming in from outdoors, say at zero. That is what struck me. I have had a little experience, so I do not think that that mild temperature of return would have a tendency to cook out our good gray iron. Now then by this sudden change of temperature from the feed to the return or from the inlet to the outlet of this radiator, it being of such a different temperature—rather that sudden change or the great diminishing of heat in the air would indicate that the radiator was highly efficient and that it would increase the rapid circulation of the air in this confined system. I suppose that is where they get the rapid circulation by sudden change in the air, and if it is hermetically sealed so that it is given off in the form of a gas, you might say, at high temperature, and cooled again and returned, I do not see where we are going to burn out anything that would be injurious to the construction of our generator.

Mr. Chew: There is another question following that up. When you get the air coming into the furnace at zero, and it is necessary to have it come out at, say 20 degrees, in order to have it do effective work, the fire-pot necessarily would be at a white heat; while, if you are bringing the air constantly back at, say 100 degrees, it would not be necessary to heat the fire-pot to so high a temperature. Consequently there might be a durability with this system that is not found with the common system. I would like to have some gentlemen express their views as to the correctness of that deduction.

Presiden Crane: There are certainly some of our members who can answer that question. I think that is a very important one to consider. From my limited experience with furnaces I believe that it is the observation of most furnace engineers that there are some deteriorating effects of the fire-pot from very low temperatures. I think some of our members could enlighten this Society and these other hot-air furnace members on the discussion of the problem.

Mr. Oldacre: In my experience I have noticed no deteriorat-

ing effects whatever from cold air, be it ever so cold, zero or 10 below. That is my lowest practical experience—10 below zero, and the highest temperature that I have ever noted in any of our work where the temperature outside was very low was about 190 degrees as the temperature of the air that came from the register that was in the third story outlet. But that I consider even too high, and it should be overcome by making the pipes larger and using a larger quantity of air at a lower temperature. A temperature above 140 or 150 should not be countenanced in a warm air heating system when properly put in. A large volume of air should be depended upon instead of a small quantity of air for various reasons. That is, the larger the volume of air, the nearer the condition of that air approximates to the condition of the air outside. The larger the volume of air and the lower its temperature the nearer will its humidity approximate to the relative humidity of the outside air; as we know that if we heat air and expand it we increase its affinity for moisture, and the higher we heat it the more its affinity is increased and it increases more than in a direct proportion, and for that very reason it is necessary to depend upon large volumes of air at low temperatures. Beyond that also the air at a low temperature is not affected by the outside pressure as much as small quantities of air at high temperature.

Now as to the burning out of the fire-pot or any of the interior parts, it is pretty well known that the greater the difference existing between the air that is passed over the outside of the fire-pot and that of the temperature of the inside, the greater the amount of heat that is absorbed or taken away by the air.

Mr. Roys: I think that the member who has just spoken is talking of an ideal system as put in by a person who makes a study of hot air and puts in what we call an ideal system. I think what the Doctor is working on is the common ordinary practice of hot air furnaces. I know that ordinarily the furnaces as put in in the usual manner that the air coming from the registers will sometimes go as high as 400 temperature coming from the registers. I know from practical experience that only in the mild weather does it ever get down to 140 or 150 coming from the registers. The usual temperature coming from registers in the ordinary hot air furnace will register from

150 to 400. What the Doctor is overcoming is the conditions which arise from the commonly installed plant—not the ideal plant or as it could be put in.

Mr. Oldacre: One thought arises in my mind—would not the casing of this heater be intensely hot and would not there be a large amount of heat lost in the cellar where air was taken in at such temperature? Because in my experience where the air is taken in from outside, the temperature of the casing will remain comparatively low. That is to say, you can put your hand on the casing at any time when the apparatus is in operation; that is if there is only one thickness of asbestos between the outside casing and the radiating drum or fire-pot, and I have noticed always that if the casing is hot there is some trouble in the apparatus and the hot casing would indicate the poor circulation and would indicate that there was a possibility of the heater burning out very soon.

Mr. Roys: As a hot air furnace is commonly installed, when it is used in cold weather it would be impossible, in some instances, to hold the hand or even to touch the top of the casing. I do not know but that fire insurance writers say that there are more fires coming from the heat in the pipes going in up in partitions than from any other cause in cold weather, which would indicate that those pipes must be at least 400 to ignite wood, and commonly, if you put your hand on a hot air pipe of a furnace, you cannot hold it there. I am talking of furnaces as commonly installed.

Mr. Oldacre: I would like to ask the gentleman who just spoke if he could point to a single house that was actually set on fire by a hot pipe itself or directly attributable to the hot pipe—not the chimney nor faulty chimney construction, but to the hot pipe.

Mr. Roys: I must say that I do not know from personal experience, only from Mr. Sims, of the Board of Underwriters, who claims that there are hundreds of such cases, from personal experience.

Mr. Switzer: I will answer Mr. Oldacre that I know that a residence has been set on fire by a hot-air pipe passing from the furnace to the wall pipe. The wall pipe was put in single without any protection, asbestos or iron lath, or even double safety pipe, and upon investigation by the underwriters and

heating engineers that were called in to ascertain the cause of this fire, it was discovered that the air supply had been trapped; to a certain extent that this furnace was air-bound; that the circulation was imperfect, that there was no ventilation to the rooms on the lower floor. This was at 10 degrees below zero and there was a 30-mile gale blowing, whereby the atmospheric pressure forced the air into the lower rooms and they continued to get colder and the hot air pipes did not circulate the heat into the lower registers, and this 8-inch pipe that supplied the stack to go to the second story became so hot that it ignited the woodwork, the lath and the joists, and burned out the centre of the residence at midnight, a high wind blowing at the time and low temperature.

I desire to go on record as stating that one of the great objects of this Society is to educate the laymen that are installing furnaces, bring them to a higher standard and acquire the results that Mr. Oldacre has referred to which are absolutely possible, and if the furnace manufacturers, as well as the engineers of furnace men installing heating apparatus, would become familiar and acquaint themselves with modern practice, the standard of furnace heating would be brought to a much higher level, and it is within the province of the American Society of Heating and Ventilating Engineers to be responsible for that being done.

Now, Mr. President, it is not with a view of criticizing this paper of Dr. Aylsworth's that we enter into this discussion. It is information that we seek. It is certainly a departure from the accredited practices of furnace construction.

In regard to the deterioration of castings and fire-pot construction, I trust that the time will come when our committee on tests may be able to have the means at their command whereby they may demonstrate the utility of the different qualities of castings. It may not be within the province of this Society to take up the metallurgy of iron and ascertain the necessary mixtures of the various grades of iron to make a casting that will insure durability and strong radiating surface, yet it is a fact that with certain mixtures of iron in foundry practice the radiant quality of the casting depends upon its chemical composition. There are certain mixtures of iron that have been brought to the attention of the committee on

tests of the American Foundrymen's Association that are shown to be more desirable for the radiation of heat in furnaces, boilers and radiator castings than other mixtures.

Dwelling a moment on this question of hot casings, the lack of ventilation necessitates the casing becoming superheated and a large amount of radiation is lost in the cellar or the furnace room and that can only be overcome by perfect ventilation.

Secretary Mackay: As to the question of the necessity for ventilation to prevent loss of heat in the furnace room, it seems to me that this is only a new point that comes up. That can be obtained by perfect insulation as well as by ventilation —perhaps better.

Then as to this question of fires, Mr. Switzer says that under certain conditions hot air flues have caused fires, and I have known of fires under similar conditions. In the good hot air installations that we hear of, the average cold air supply has a damper which is put into the hands of a $10 a month servant and that brings up exactly the same conditions that Mr. Switzer mentioned. They can shut off the cold air, and then the condition arises just as it did in that case.

There is one point that does not seem to be touched on in Dr. Aylsworth's paper. That is, he does not seem to have provided any means of regulating the heat in any room by means of valves or dampers so as to entirely shut off the heat of any room. What I would like to find out is what effect that would have on a given size of furnace, if it requires a furnace with an 18-inch pot to heat his building and he puts in these dampers and shuts off half of it and does not diminish his furnace, is he not going to knock his furnace to pieces in a very short time? I think that ought to have some consideration, because, of course, if the entire house is required to be heated to the temperature of the radiators and the furnace will heat them, then it would be all right; but it would seem that in all cases it would be desirable to cool off a room as well as to heat it if necessary.

Mr. Cobey: Mr. President, the system under discussion is in a primitive form and there is no reason why those extra appliances could not be brought out afterwards, such as thermostatic control for various divisions, and I think that that is a matter that need not necessarily be embodied in the paper.

Speaking of air for heating and ventilation, my idea is that sooner or later we will adopt the direct radiation with a separate system of ventilation. My experience has been that the combination of the two has been a very disagreeable one, when we take long lines of ducts where vermin and small sized animals, one thing and another, can get in there and die. I do not think it is desirable to force the air through the same duct that the heat comes through. I think the heating and ventilation should be two separate systems, and I think if the Doctor's apparatus was worked into a thorough system with a separate system of ventilation, that would be a system that is almost ideal. Of course those things have to be worked out afterwards.

Mr. Chew: I suggested a point I would like to have information on and I think I will persist and see if I cannot get it. To put the thing a little differently: when you get all your air from outdoors at zero and you have got to heat 18,000 cubic feet, and it takes a furnace with a 20-inch fire-pot, will a furnace with a 14-inch fire-pot, with Doctor Aylsworth's system, heat the building? He does not waste any of the heat that he makes. The first question was, would a furnace prove more durable from the fact that it did not have to be carried at so high a temperature to heat the air to an efficient temperature in the radiator? Now I want to have the question considered, will a smaller furnace heat the same building, using the Doctor's system?

So with regard to the question of the quality of the air in the pipe, I do not see that there is any importance in that whatever. The vital point is, is it going to burn up the furnace faster, or is there going to be a benefit derived from the use of this system through the use of smaller furnaces?

Mr. Schaffer: To answer Mr. Chew as to whether a furnace with an inside circulation will last longer than an outside circulation; I will say it will. That is to say, with the same sized furnace to do the same work the furnace will last longer, or the same work can be done with a smaller furnace.

Mr. Kent: I would like to ask Dr. Aylsworth to state the size of these radiators. I do not find it mentioned in the paper—and the sizes of the rooms are not given in the paper either.

Dr. Aylsworth: The size of the radiators varies. There are

three sections in them. The size of the radiators varies with the number of sections. At present the intention is to have a four-section radiator the limit. I think there is no reason why it should not be increased, except for the bulkiness of the radiator. Each section of this radiator, as near as we have been able to figure it, has 14 sq. ft. of radiating surface, giving in a four-section radiator 56 sq. ft. which is about all the radiating surface you require in one spot. If you have a room large enough to require two four-section radiators it would be better to have them in two parts of the room. There is one room 22 by 15 feet on the ground floor, and in it are two radiators having three sections each. But to obviate the necessity of giving all these data I would say that the number of feet of radiating surface is figured so that one foot of radiating surface will heat from 40 to 60 cu. ft. of space. The variation is due to the variation in exposure and the amount of glass and all that kind of thing, the same as you would have it in hot water or steam.

I will make the best reply I can to some of the statements that have been made. One is the short-circuiting. Now, as a matter of fact, the colder the exposure—that is a radiator sitting by the window instead of an inside wall—the more rapid the circulation. The colder the air becomes in your radiator the quicker it goes back to the furnace, and it does that more satisfactorily than with hot water, simply because the air travels more rapidly than the hot water does.

I think it was Mr. Mackay who mentioned the question of dampers. I would say that I had not seen this radiator before it came here, but the instructions to the manufacturer were to place the damper in the pipe, that is the inflow pipe of the radiator, at the bottom of the radiator, just an ordinary smoke pipe damper. In practice I had dampers on some of the radiators and it had no effect whatever on the circulation through the other radiators.

Secretary Mackay: Or on the furnace?

Dr. Aylsworth: The effect on the furnace is exactly the same as what you would have in hot water. That is, if you shut off a portion of your system it does not burn as much fuel. You do not make the furnace as hot; you do not need to, because the air will pass through with much more rapidity.

On the question of ventilation the gentleman who brought

the matter up suggests an entirely different system for ventilation from what you have in connection with a heating plant. I think he refers in that case to forced ventilation or indirect. As has been pointed out, this system is not intended to heat large buildings. It is intended for ordinary sized dwellings and small churches and things of that kind. But if anybody owning a building like that desires ventilation more than they get through the cracks of the doors and windows, the intention is to place another pipe outside of the exhaust pipe of the radiator connecting directly with the outdoor air. In that way you will introduce a certain amount of fresh air warm into the room. That hot air can be shut off of the register the same as you would shut off an ordinary hot air register, so that the question of ventilation is solved in that way.

Another question was the smallness of the furnace, which, I think, was answered by a gentleman sitting here. There is no question whatever that the size of the furnace will be reduced in order to do a certain amount of work. The size of the piping is also reduced.

Mr. Kent: I would like to ask the Doctor how he figures that 50 per cent. of the heat is lost in the attic. That would indicate that there is nearly as much heating surface in he attic as there is in all the radiators and pipes in the rooms.

Dr. Aylsworth: The reason I figured it was that the attic covers, of course, the whole building, making a third story, and the temperature in the attic was much higher than it was in either of the floors below.

Mr. Kent: Was the radiating surface as large?

Dr. Aylsworth: I have not figured it, although there was a great deal of piping there. You must understand that some of these radiators were supplied by piping that started as a ten-inch pipe and travelled 34 feet before it commenced to descend to the radiator.

Mr. Kent: How would you change that in another building? Would you put the horizontal flow-pipe below the ceiling?

Dr. Aylsworth: The horizontal flow-pipe would be below the floor. It would come up through the floor and then go right back again, the same as the hot water system. As ex-

plained in the paper, this overhead system was installed in my own house simply for the purpose of showing that I could turn the corners and put the heat where I wanted it.

Mr. Chew: I would like to ask Dr. Aylsworth a question again. He says that the system which he has installed and which has proven efficient in his opinion would not work as well as if it had been a direct flow-pipe under the first floor or along the cellar ceiling, then come up to the radiator and through the return pipe directly back. I see his plan in one of these cuts, Fig. 7, at the left of the cut. He seems to favor the system of piping shown to the left of the cut. It would seem to me there might be obstacles met with in that system of piping that are removed in the other. In the system to the right the hot air has a chance to move quickly to the highest point, and start circulation, and the cooler air flows around to fill the space. I think that the circulation through the other system would be more sluggish, and I would ask if he had practical experience along the lines to know that he is right in his preference for the other?

Dr. Aylsworth: I have had experience in it. The first building heated is installed in that way, and it is decidedly preferable to carrying through the attic.

Secretary Mackay: I would like to ask if in this cut it is not intended to show a flow and return pipe, as that return pipe might have been taken from the bottom of the flow-pipe. As I understand, that is only a side elevation of it, and there is a return pipe beyond the flow-pipe from the radiator.

Dr. Aylsworth: You are quite right, sir. The return pipe on that figure 7 comes up on the other end of the radiator.

Mr. Oldacre: I would like to ask what advantages could this system have over a direct hot water or direct steam system; that is, considering that water will take up heat quicker than air will take it up.

Dr. Aylsworth: The question, Mr. President, is what advantages this system has over hot water or steam heating. I would say that the only advantage it has is in its cheapness, and that is the one advantage in installation—its cheapness. It also has an advantage in the slight amount of repairs necessary, because there is no frost or foul or superheated steam or anything of that kind to look after. It has these ad-

vantages. But the great advantage it has is that a great many people do not feel that they are in a positon to put in steam or hot water, although they may think it the ideal system of heating. I claim that this system will give all the advantages that you get from either of the others and for a good deal less than half the cost.

Mr. Switzer: I would like to ask Dr. Aylsworth if this piping was constructed round, oval, or square, and what, if any, percentage of round pipe was used in the installation?

Dr. Aylsworth: The piping carrying hot air to the radiators were round until they reached the point where they should enter the partition. They were then made square or oblong, and the return flow-pipes were round.

Mr. Ashworth: The discussion seems to be about concluded, and this paper has impressed me as a valuable contribution to the Society, and furthermore from the fact that it has drawn out a multiplicity of ideas on this method and various other methods of heating. It strikes me with somewhat of a humorous turn. My cellar is a museum of diaphragms, thermostats, regulating valves and automatic devices; they are lying around there as the wreck of past experience. There was a time that I thought possibly I knew a great deal about heating a house, and one morning I was compelled to haul down my colors, and after expressing myself in some language which was not exactly classical, I started down to the office. I had not been in the office more than an hour before a gentleman came in and wanted to know what I knew about house heating. "Well," I said, "about a week ago I thought I knew it all, but this morning I don't know anything." Now, this discussion this morning has given new birth, as it were, to this idea, and I shall be very much prompted to clean out all these monuments of the past and commence anew, for I do believe that if there is anything that baffles the engineer it is to economically, thoroughly, and efficiently heat a dwelling house.

The matter of fires from flues has been spoken of. I am under the impression that many fires brought about by hot air, etc., have been brought about by the accumulation, in time, of dust and other materials that are exceedingly combustible at a low temperature and somewhat explosive. We

know that such things have happened in manufacturing establishments. Spontaneous combustion will take place under certain conditions with certain accumulations in quite a length of time. These are frequently in places inaccessible, never thought of and impossible to clean out, and it impresses us with the importance of a thorough protection against fire.

Mr. Chew: I would like to ask just one more question of the Doctor. In determining the size of the pipes to go to the different radiators do you have any special rule that you follow? Have you a rule of determining the area of the pipe? Is the area based on the number of sections and the space in the radiator, or is it based on the size of the room?

Dr. Aylsworth: The conduit through each section of the radiator is supposed to have an area of seven square inches, or 1 by 7 inches. A 3-inch round pipe has also 7 square inches. If you have a square pipe you want to arrange that so as to have the same area. If you added another section you would simply increase the size of your pipe going to that radiator. If you have half a dozen radiators you count up the number of sections you have in those radiators and multiply the number of sections by seven, which will give you the area of the whole number, and start your pipe from the furnace with that area. That is all there is to it. There is no special arrangement as to the horizontal distance the pipe is to be carried or the number of turns that are to be made. It is simply to have your pipe leading to the radiator of the same area as the sections in the radiator, and the only practical point in connection with that is to conduct your air as close to the radiator as you can in the largest pipe you have. Do not make your divisions farther away from the radiator than is necessary, because the smaller the pipe the greater the radiation before it reaches the radiator, and it makes no difference in the return flue whether the pipes are supplied from one main or not. You can supply half a dozen radiators from one main with hot air and you could take the flow back to the furnace in three or four pipes, as you choose. It makes no difference as long as you keep the total area the same.

Mr. Oldacre: May I suggest that it would be a good idea

that at our next annual meeting the Doctor send us some further information, that is to say, as regards the questions that have come up here. There have been a number of questions asked, some of them answered in a certain method, others in a different method; but could he not give us further information on this interesting question?

President Crane: I hope the Doctor will take that into consideration and grant the request.

Dr. Aylsworth: I will think about it, Mr. President. I would say that I have made arrangements to heat a dwelling and a small church in what I call a reasonable or rational manner, and data obtained will not only be supplied to the Society, but to any one who wishes to have them.

## CXVI.

## TOPICAL DISCUSSIONS.

### NO. 1.

**"What is the Proper Method of Rating Steam and Hot Water Boilers for Heating Purposes?**

Mr. Kent: The Secretary has handed me the stenographer's report of the annual meeting in New York, and my own discussion on the subject at that time, and suggests that I bring it forward here.

Mr. Kent read from the notes of his discussion at the New York meeting. (See page 167, this volume).

Mr. Harvey: Would there be any rule as to the proportion of draft?

Mr. Kent: The draft question I have not figured, but a sufficient pressure of draft is needed to burn $6\frac{1}{4}$ pounds of coal per square foot of grate; that would be probably not over one-tenth of an inch of water column. That would probably burn that coal if it was a fair grade of nut coal. If it was a very fine coal it would take more than that.

Mr. Thompson: So far as my knowledge goes I think Mr. Kent's proportions are very nicely arranged, but I do think that one of the factors he has left out, the flue areas, which is one of the most important features, especially in a house heating boiler. I do not think it has received the consideration that it ought to have. The question for a long time in my mind was, which was the better, a large number of moderately small flues—I am speaking of using hard coal—or a small number of large flues. I mean flues through the boilers, I am not speaking of chimney flues. And to-day I am very largely in favor of having a small number of comparatively large flues, and turn the gas through in large volume, for the reason that in one or two cases that came under my notice where boilers were arranged, you might call it straining the gases through

in a very limited space, and having the heating surface above the fire crown sheet, the boiler would prove very ineffective, and I thought it was because the flues were entirely too cramped, that the gas went through in such small thin sheets that it was cooled down against the wall. I would like to have Mr. Kent's views on that subject.

Mr. Kent: This (referring to sketch), represents a horizontal tubular boiler. There is a tendency for the gases, going through the flues into the chimney, to select the paths of least resistance, and if there are a large number of flues carried in vertical rows, the gases will tend to go through the the upper flues; also, if the gas is drawn through too small passages it checks the draft very badly; so that in power plants they have generally come to the four-inch flue as being standard. Three and a half and three-inch are not considered as good as four-inch, and larger than four-inch are not considered advisable for the reason that they take too much room, that is, they would require the boiler to be of larger diameter. For economy of cost of the boiler itself, the smaller the flues the greater amount of heating surface we can pile in the smaller space. Consequently we use small tubes in locomotive boilers, but in stationary boilers we enlarge them up to four inches. I have not given any chimney flue areas and size of gas passages, for the reason that there are no accurate data published on the subject. It is all rule of thumb and guess-work that we have, and we have also the trouble that architects do not put in big enough flues and chimneys, and we have this trouble which the gentleman speaks of, of too contracted flue area. So it is well to have as much flue area as you can practically, and if you find by experiment that a boiler is not giving what it ought to do from the amount of grate surface it has, we may expect that the trouble is short-circuiting of the gases through the upper tubes, and that can be remedied by putting a baffle in front of them or else by putting retarders in the upper row of flues; that is, little baffles in each of the upper tubes. Considerable improvement is often shown by doing that.

Mr. Thompson: I gave my views to a man who has been doing a very large amount of high pressure work, and I was rather gratified to hear him say that he found that a given horizontal tubular boiler with a given number of three-inch

flues was given a certain rating in horse power. The same boiler with a less number of four-inch flues would be rated lower. "Now," said he, "we found just the reverse. We found that the same diameter of boiler with a less number of four-inch flues gave us a higher efficiency than the boiler with the three-inch," and I thought that was an argument in favor of my own views in the matter.

About heating surface I would say, there are many boilers that I believe have too much heating surface. I am speaking of house heating boilers. I think there are plenty of people here who will agree with me, that if you take a round horizontal boiler, where the sections are piled on top of one another, and you find the boiler is not working well and you take off a section, you will get the boiler to do very good work. Where was the trouble there? Want of combustion, want of draft We do not hear so much talk about that in the engineers. meetings. I think that is a subject you ought to bring up—the combustion, because it certainly must be at the root of all efficiency. The boiler makers say if you have a large amount of heating surface piled up and the flues are small and narrow and tortuous, the friction will be so great that the gases are retarded and the flow of air through the coal is entirely insufficient for its combustion, and when we are told that that perfect combustion, as compared with imperfect combustion, is as a little better than three to one, we can see what a tremendous field there is there that ought to be cultivated. I think that is where the boiler manufacturer makes a mistake very frequently in endeavoring to get in a large amount of heating surface, saying, "My boiler has so much grate surface and my heating surface is twelve to one." I think he gets in too much heating surface. If you take a section that is three inches thick, and put a three-inch flue through it, you double the heating surface, so that you can crowd in a tremendous lot of heating surface. I believe to-day that a more successful boiler, a boiler that will meet with the greatest number of friends, is the boiler that has comparatively short flues, a large amount of direct heating surface, and then it is up to the fitter who puts it in to arrange it so that it will not be wasteful of fuel, which can be done by a system of dampers. When you build a boiler with long flues, you are handicapped in the beginning

if you happen to get on an indifferent draft. I have had one or two cases where we have taken a boiler out and put in one with free draft and it worked perfectly in the same chimney. I believe the tendency is to build boilers with more direct heating surface, and that of course would bring up the question of the heat in the smoke pipe. I found where I had a chance to measure these things that I got more out of the fuel at a temperature over about 350 degrees in the smoke pipe. I seemed to get more out of the coal almost invariably than at a lower temperature.

Secretary Mackay: I would like to ask Mr. Kent if he has had any experience, or if he considers there would be any advantage, in using say a four-inch tube in a horizontal tubular boiler below, and making the top row of tubes three inch. Would that be any advantage in the construction of the boiler?

Mr. Kent: That might be a good plan to make a little obstruction in the upper tubes that way. The same object would be accomplished by putting retarders in the upper rows of four-inch tubes.

Secretary Mackay: I would like to say in connection with Mr. Thompson's remarks that my experience has been that it was an advantage to reduce the combustion area from the top of the combustion chamber to the smoke outlet about in the same proportion as a funnel. That is, you would start at a certain point, the combustion chamber, you would finish at a certain point, the smoke outlet; that it was wrong to abruptly change the area of the flues from one to the other, and that the proportion of the smoke outlet area should have some connection with the boiler; that is, that the area of the smoke pipe could be 20 per cent. of the area of the grate of the boiler, while the flues in the boiler itself would gradually reduce from from 100 to that 20 per cent. I found that that gave a good combustion in your combustion chamber, and full efficiency up to the point of the smoke outlet. I have also found that it was a disadvantage to make a continuous upward fire travel from the combustion chamber to the smoke outlet; that it was a positive advantage and economy of fuel to have a diving flue which in Mr. Thompson's opinion has been an objection, largely on account of lack of draft.

Mr. Ashworth: Speaking of the rapidity of the gases having a tendency to enter the upper rows of tubes in the back connection, I have found by increasing that back chamber far beyond the standard which is set down in our regular specifications, that I have constructed a chamber in which those gases were more in a quiescent condition; they were a reservoir as it were, and there was a more equal distribution of the gases through the lower tubes than by the narrow, constricted chamber that is frequently seen. The rapidity of the current would impinge rapidly on the back connection and shoot into the upper row of tubes. By extending it back one-third more than the standard, I have found that I gained considerably in the efficiency of my boilers.

Mr. Cobey: I find that the best advantage to which I could work the new tubular boilers that I installed, was to close the damper partly and force the draft so as to establish a partial pressure in the tube so as to equalize the distribution of heat. I found that to work to very great advantage over the old system of waiting for the damper to draw, because it will not draw through the tubes evenly or of an even distribution. By partly closing the damper or nearly closing it and forcing the draft, it had a tendency to fill the entire tube surface and establish a partial depression in the fire-box as well as the tubes. I found that it increased the efficiency of the boilers and did with less fuel.

### TOPIC NO. 2.

**"The Relation of Space Between Sections to the Efficiency of Steam and Hot Water Radiators."**

Mr. Dean: It seems to me that this is an important question for the Society to take up. It simply means, shall the radiation be supplied with an abundance of air to circulate in there and carry off the heat radiated, or shall we accept radiation just as it comes, no matter what space happens to be between the sections? This was brought to my attention very vividly in an indirect way. Out in the Western States there was a man telling about a one-inch pipe supplying a fifty-two square foot radiator on a single pipe system and doing it noiselessly. I was very much interested to know more about that. By inquiry I found out later that his fifty-two feet was set in a

recess in the wall with a cast-iron grating in front of it so that the air really had no chance, had no good chance to get to and from it. The air must have circulated very poorly, and I do not think that that radiator did over the work of perhaps a sixteen or twenty foot radiator, and for that reason that number of square feet of radiation did carry noiselessly, but of course it was not doing its proper amount of work. It seems to me that, in a way, expresses what we want to get at, the distance between the sections of radiators. Shall we have a large opening so that air will get to and from it? Or shall we have a smaller opening and rely principally on the outer surface for the radiation?

Secretary Mackay: While it would seem possible to mask a radiator and place it in such a condition that it would not give its most efficient result, it seems to me that this particular question applies more directly to flue radiators. The average direct radiator is spaced two and a half inches on centres, and the average amount of space that that radiator takes up is one and three-quarter inches, giving about half the amount of air space that it has section, and as far as I have been able to discern, the average direct radiator has given good results. The single column gives more than the two column. The two column gives better results than the three column, and the three column gives better results than the four column; but the necessity for more air, and the appearance of throttling, seems to take place more in what would be termed flue radiators, and according to discussions which have taken place before this Society, the average flue radiator would give certain results up to 25 or 28 inches in height, different results beyond that, up to 38 or 44 inches in height. But according to certain observations, the 25 to 28-inch flue radiator has apparently given as good results in condensation and heating as the 38 or 44-inch radiator with 50 per cent. more surface, and the reason advanced for the lack of additional results from the higher radiator with more surface has been a lack of sufficient air space between the sections to enable the radiator to perform its full functions or give off heat in proportion to its capacity. I rather think that an ordinary direct radiator, except perhaps in a few exceptional types, has had sufficient air space to develop its full capacity, but that the lack of air space

between the radiators has been found most apparent in the flue radiators, and those in the greater height, above say 26 to 32 inches.

Mr. Dean: I should think from Mr. Mackay's remarks that there is a chance for improvement on the direct radiator as well as the indirect, because if I understand it properly, the space between the sections is not more than half to five-eighths of an inch. Is not that the space that is generally between them?

Secretary Mackay: One and three-quarter inches of actual section and two and a half inches of space. That makes about three-quarters of an inch of space between each section.

Mr. Dean: Five-eighths to three-quarters of an inch between sections. Now, if in the flue radiators the air absorbs all the heat that it is possible for it to absorb, is it not possible that a direct radiator could be made considerably more efficient by giving it a little more air space at which to deliver the air to the radiating surfaces, to take up the heat units and carry it off and get it out from the radiator again out into the room?

Secretary Mackay: I would like to say that one-half of the space in the average direct radiator has 50 per cent. more air space than the space which I mention, the radiator tapering down in the two outside columns one-quarter of an inch at the outside to about one and three-quarter inches back; so virtually, if you average it up, there is more space between sections in the average direct radiator than the amount of three-quarters would indicate.

Mr. Roys: Mr. Mackay says the two column radiator is more effective than the three and the three more effective than the four. That would come right back to the discussion we started on, to find out why the two gives more than the three. Is it a question of air space or the radiant heat being not absorbed, or something of that description? He said in the regular direct radiator that the two column radiator gives more heat than the three column, or is more effective than the three.

Secretary Mackay: My experience is that in a single column radiator the entire radiation or almost all of it is outside. In a two column radiator there is a certain amount of surface radiating against itself. In the three column radiator the

centre column is surrounded by two columns which are radiating against it. In the four column radiator there are two outside columns radiating against the two inside columns. That interferes with the interior surface of the radiator being as efficient as that which is exposed to the air, and the relative proportion of efficiency of the same radiator in two, three, and four column seems to be about 8, 12, and 19 per cent.

Mr. Dean: A manufacturer of radiators told me that he made a direct radiator, and after receiving complaints, had it tested, and he said it did not condense as much as it apparently should condense, and he asked the man who had done the testing why, and he told him because there was not sufficient air space between them. He said he changed his patterns, made more air space between the sections, and that the radiator condensed considerably more steam after the change than it did before. It seems to me that that would show that really there is room for improvement in the direct radiator.

Mr. Thompson: In the case you just cited, there was 17 per cent. increase of efficiency by spacing the radiators further apart. I know the case you refer to.

President Crane: I believe this is a subject, gentlemen, we ought to think seriously about. One of our members, who has taken a great deal of interest in these matters, mentioned to me to-day that we ought to find out the correct rating of radiators, that we have not made enough experiments to satisfy ourselves that we are entirely right, and he suggested that the test committee be requested to take this matter up, and do something in that way to ascertain for us just what the efficiency is of each radiator that is brought before us. I think that within another year, probably this same subject will be discussed from data that we will have in our own possession. But nevertheless, if there is anything further to be said on this subject, we would like to have it now and take it up and discuss it thoroughly, so as to give that committee as much information as we can as to what we have found out by our practical experience.

Mr. Martin, we would like to hear from you.

Mr. Martin: I do not know that I feel competent to talk to this body of men. I am not a heating engineer or a man of experience in the line that older men here have followed.

But I could state one little instance in our own manufacture of the first radiator we brought out. The sections were rather close together. We did not think that we had sufficient air space, and have abandoned it for that reason. We found that a radiator carrying the same amount of surface, with more air space, was infinitely better for the use of the trade, gave better results, and we found it much more efficient than our first production was. We have always maintained that you could not drive air to the direct radiator, you had to coax it there, and in doing so you had to have the place for it to come. I think that that has a great deal to do with the efficiency of the radiator, and we have worked on that line for a number of years. It seems to me that the admission that a two column radiator will do more work than a three, and that a one column radiator will do more work than a two, is almost sufficient justification for saying that the air spaces have more to do with the efficiency of the radiator than has heretofore been considered.

President Crane: I do not think there is a practical man in the business but knows that to be the fact.

Mr. Smith: We all know that a single radiator loop, set up in the middle of a room, will do more work than if it is brought in contact with any other section, because the whole work of the radiator is to transmit heat to the air, and it cannot transmit heat to the air unless it comes in contact with it. The other extreme is to have as much surface as you can in the limited space. The point to be attained is to get as much *effective* surface as possible in that limited space. It is a question of where to draw the line—like Mr. Kent and the boiler tubes.

President Crane: That would be the idea of any experiments we might make, to know just exactly where to draw the line. We want to keep the limit in the space, and we want also efficiency. Is there anything more to be said on this subject?

Secretary Mackay: I would like to say that my practice has been this: When I had sufficient wall space to use a one or two column radiator, I have used it. When I was contracted so that I could not use it, I have placed my surface in two and three and four columns, but I have increased my surface as I reduced the air space that it covered until I used from 12 to

15 per cent. more surface in four columns than I used in three and eight or ten per cent. more in three columns than I used in two. I did not feel that there was a lack of air space between the sections of those radiators that I was buying, but I felt that there was a loss of efficiency in the surface, because the radiator was radiating against itself, instead of against the air in the room.

TOPIC NO. 3.

**"The Advantages and Disadvantages in the use of Wrought or Sheet Iron in Steam and Hot Water Radiators."**

Mr. Dean: Mr. Chairman, I have special interest in this, and I will mention what I have seen in the New England States. I do not think there are many men who have travelled in the New England States but have seen the sheet-iron radiators, and I think they have seen them rusted out. They seem to rust out along the bottom. Of course if there is a hole through them, that is all there is to it. They heat up quickly.

Mr. Cobey: In reference to the advantage of wrought-iron radiators, I have had a little experience with them. I find in the use of steam they clog up very fast. Oftentimes I have sawed them in two with a hack saw, and found them solid. That has been the drawback that I find. They corrode to such an extent that they become solid, just like a piece of iron bar.

Mr. Martin: I would like to ask the gentleman if the inside of the radiator had been treated with any solution or coating before they were put into use.

Mr. Cobey: No. It was common wrought-iron pipe, with the end closed and a diaphragm inserted into it.

Mr. Roys: I would like to relate a little experience I had with some wrought-iron radiators. I took out some—I believe they call them the old Gold radiators. They had been in the building for twenty-eight years, and being curious to know the condition I would find them in, I took a hack saw and sawed off various corners, split them up, examined the inside, and found the one that I experimented with to be perfectly clean and clear. I was surprised. There were no pin-holes in it, although they told me that some of the other radiators had rusted around the valves. But I found this

radiator in as good condition almost as the day it was put in. I did this just merely for experiment, and seeing this question come up, I thought I would let the members know. It was a surprise to me. I expected to find pitting, or else sediment in the bottom, or something, but I have the pieces in my desk at present, showing that the radiator, from the different parts I cut out, is as good as the day it was put in.

Mr. Switzer: I would like to ask if there are any members present who know anything about the relative advantages of the material that may be used at the time in radiators. The gentleman speaks of a radiator that he tested, and there are radiators that are of more recent manufacture, whether iron or steel, made of certain materials, of higher of lower carbon—whether that would have any influence in more corrosion or less corrosion. Could Mr. Kent advise us on that subject?

Mr. Kent: Generally it is believed that wrought-iron corrodes less than steel. That is about all I can say about it.

Mr. Switzer: Wrought iron?

Mr. Kent: Wrought iron corrodes less than steel plates. Among the different kinds of wrought iron, the better the wrought iron, the more it will corrode; the meaner and commoner the wrought iron, the less it will corrode, and cast-iron will corrode still less, and the finer grades of steel and the finer grades of wrought iron corrode the most. I think the reason is that common wrought iron is protected by the slag which it contains, and cast iron by a skin of magnetic oxide. Perfectly clean and pure iron corrodes very rapidly.

Mr. Switzer: What would you think of the relation of charcoal iron? Will it corrode very rapidly?

Mr. Kent: Yes, unless it is covered with an oxidized surface. Planished iron made in imitation of Russia iron, with an oxidized surface, will corrode very slowly, but a clean surface of the very best charcoal iron will corrode rapidly.

Mr. Switzer: Do you go on record as stating that you would not approve of sheet-iron in any form for steam and hot water radiation and durability?

Mr. Kent: Not if it was good clean sheet-iron. If it was coated with oxide or coated with varnish of some kind of asphalt or japan, then it might be all right.

President Crane: Is there any further discussion on this topic, No. 3?

Mr. Cobey: Speaking of treating these irons with oxide and asphalt and different things, has it not a tendency to close the pores of the iron so that it will have less radiating power?

Mr. Kent: I should think it would; probably so.

Mr. Cobey: What makes me speak of it is that I knew of a doctor who recommended giving the radiators in a certain building in the State of New York three coats of this Pegamoid paint, so that it would give it a glossy appearance.

Mr. Switzer: I would ask if even furnishing a coating of the non-corrosive material on the exterior would have any effect on the action of the interior of the radiator?

Mr. Kent: I do not think hot steam will corrode at all. On the contrary, it is apt to make that oxide coating which is a preservative. The thing which corrodes is water containing air. Steam pipes have been known to last for years where the return pipes would last for only a short time. One of the things that corrodes most rapidly is the sheet steel house boilers, the kitchen range boilers. They sometimes have a life of only three or four years, and they are quite thick, about an eighth of an inch thick or more, and they have pin-holes through them. A very high temperature of steam will make a blue coat on steel which is a protection.

Mr. Dean: I would like to ask Mr. Roys the approximate thickness of the metal in the radiator he sawed.

Mr. Roys: The gauge of iron was about No. 20. The radiator was painted on the outside and then grained to imitate walnut. The gauge of the iron I should judge is about No. 20. The side of the radiator next to the wall was not painted at all, perfectly clean and clear, and the inside of the radiator—I am speaking of the interior of the radiator—was clean and clear, and the gauge was about No. 20.

Mr. Cobey: For a point of information, I would like to ask the previous speaker if the radiator was of the finger type or was it connected between two manifolds, so that a current could pass from one to the other?

Mr. Roys: The radiator I cut apart was two flat surfaces of, I should say, about six feet long, and possibly thirty-six to forty-two inches wide; just two pieces of sheet-iron doubled,

sealed around, no extended surface at all, perfectly flat surface, what is called, as I understood, a Gold radiator, and about every six inches there is a rivet put through, the surface is pressed in and simply riveted in with copper rivets.

Secretary Mackay: I would say, Mr. President, that these radiators have been used for a good many years, both singly and in clusters, and when used under a low pressure, under virtually no pressure at all at the radiator, there seems to have been no wear-out to them, while they had from 50 to 100 per cent. more efficiency than the average cast-iron radiating surface. The objection to them was the amount of space that they took up and their appearance in a room. But I do not know that in my entire experience I have ever found a single one of them corroded out—that is so that it would leak; while one of my first experiences away back in 1870, was on that make of radiator, placing it in a building. If it were used under higher pressure I could readily understand that it would possibly leak, but it seemed to perform its function in regard to radiating heat in the building from the boiler, which was arranged so that it was impossible to raise pressure on it beyond a certain amount, having an open pipe five feet long from the water space in the boiler in the basement, the old Gold system, and under such conditions it seemed to have from 50 to 75 to 100 per cent. more capacity than the average radiator of to-day, depending on whether it was placed singly or in clusters.

Mr. Cobey: Mr. President, one word more. I would like to state that I think there is a difference between the two radiators, so that it would be hardly fair to get them confused. The radiator I have reference to is made of wrought-iron pipe an inch in diameter. As I understand the gentleman at the other end of the room, the one he had was similar to a tin box—sheet-iron. Of course, there is a very great difference.

Mr. Chew: At the present time there is one concern in the West making a stamped steel radiator in sections, and I understand that another manufacturer is about to engage in producing the same sort of radiator in the East. In appearance it will resemble the ordinary cast-iron radiator. The eastern radiator I understand is to be embossed, to have relief ornamentation and painting on it. In the West, the concern is manufacturing what they call a sort of combination radiator.

They put their sheet-iron in the mould and pour the casting in around it, so that they have what they call a benevolent assimilation there. They have none of the disadvantages of some of the sheet-iron radiators in having to rivet something fast, and screw the radiator valves or other things into them. They also put several of these sections together. I am not just exactly familiar with all the details of construction; but they can make an indirect radiator, and have a surface which they claim is of far better value on account of their thinness than material used in the sheet-iron part. I think these types of sheet-iron radiators are coming into the market; whether they are going to stay or not, I do not know.

Mr. Harvey: I would like to ask if there have not been a number of tests made between the old wrought-iron pipe radiator and the cast-iron, by some members of this Society, some time? It seems to me that there has been. I know that this subject has been up for discussion before, and I think there has been something of that sort gone over and thoroughly tested. Perhaps Mr. Kent can remember about that.

Mr. Kent: I have seen accounts of such tests, but I could not state where they are, or what the results have been. Professor Carpenter's book, I think, has an account of the tests referred to.

Mr. Harvey: I have never found the objection to the pipe radiator that the gentleman mentioned who cut the iron pipe. I think that that radiator must have been used for something else besides ordinary steam, or it could not have got solid. I have cut a great many pipes and taken them apart after they have been in use thirty years, maybe forty years, and the inside was as clean as could be. I never have found in all my experience that wrought-iron radiators have ever filled up at all. That is entirely different from the experience of the gentleman who said that he had cut them apart and found them solid. If a radiator was tight, I could not see how it could get air in there enough to corrode it, and as for giving off heat, I suppose one reason for giving better radiating results would be the evenness in the thickness of the iron. They would be much thinner than the cast-iron would be, and of course, would bring the heat more in contact with the air.

Mr. Cobey: If I might make a reply to the gentleman I

would say that my experience has been that the most difficult part has been relieving those radiators of air. The fingers become air-bound, and it was the most difficult thing I had to contend with to keep the air out of them and to establish circulation. I suppose the gentleman understands the construction. It is an ordinary piece of pipe with a piece of sheet-iron inserted into it as a diaphragm, so that the steam may pass up one side and down the other.

Mr. Harvey: That is a different type of radiator. The radiator that I had reference to was the return bend radiator, and you could get just as good circulation with that, get the air out of that just as easily as you can with the cast-iron radiator. That has been my experience.

## TOPIC NO. 4.

**"Can a wrought-iron nipple for connecting radiator and boiler sections be made durable with any system of coating?"**

Mr. Millard: I wish to preface my remarks by saying that about ten years ago, we began the manufacture of a steel nipple, a push nipple. Many of you are familiar with them. We have sold more or less of them every year since, and we understand at your last meeting the reports were that they were rusting out, either from the action of injurious boiler compounds, or the action of distilled water or electrolytic action. We saw our business was being endangered somewhat, and we took steps to investigate the subject and we have established a plan for zinc coating. We believe it is a preventative of corrosion and rust. We have seen the radiators themselves rusted through. We have seen the malleable nipple that has been corroded with distilled water perhaps, and we have established a plant and are zinc-coating our nipples. We submitted samples of them to Professor Carpenter of Cornell, and I would like to read his report on them. This is dated Ithaca, New York, June 9, 1903. (Mr. Millard read the letter.) I would like to say in reference to this, that this process has been adopted by the Government, and they are plating all their valves in their steamships, and they have established a plant at each one of their navy yards. It has also been adopted by the Brooklyn Bridge authorities

for protecting iron there from rust. We have samples of these nipples. I do not want to make an advertising medium out of this meeting, but we have samples of these nipples here and we would like to submit them to you and show you the tests that they would stand.

### TOPIC NO. 5.

**"The advisability of forming local chapters of the Society in different sections of the country."**

Secretary Mackay: On that subject, at the last annual meeting, a motion was made that the matter be referred to the Board of Governors with power, and at their meeting on May 1st the question was considered in all its phases, after having been previously considered individually by the members of the Board of Governors, and in committee. An addition was made to the by-laws and presented at that meeting for approval. After thoroughly discussing the subject from every standpoint, the Board of Governors unanimously decided that no action should be taken at that time, but that the question be made a subject for discussion at the semi-annual meeting. There was some correspondence, principally from Pittsburgh, some from St. Louis, with the idea of forming local associations; but, unfortunately, in Pittsburgh the communications came from those who were not members of our Society, and some of them, in the judgment of members of our Society, were not eligible to membership. Consequently it would leave them outside the possibility of becoming members of the local chapter. The addition to the by-laws as it was framed read in this way, to come after Article 9 on page 32 of our present by-laws:

"Upon application of ten members of the Society in any locality, territory or state, local chapters of the Society may be formed, if in the judgment of the Board of Governors to whom such application shall be referred, the organization of such local chapter would advance the interests of the Society; and upon recommendation of the Board of Governors, a charter may be granted by the Society to such local chapter, which shall be operated under the control of, and at the pleasure of the parent body, being governed by its constitutions and by-

laws, and such other local by-laws as may be adopted by the local chapter, which by-laws must be approved by the Board of Governors of the parent body before becoming operative and in force. Only members of the different grades in the national society shall be eligible for membership in a local chapter. Those ceasing to be members of the national society by resignation or otherwise, shall forfeit their right to membership in any local chapter. Local chapters when formed shall be named after the city, county, state or section of state, in which they are located." That, in the judgment of the committee that had the matter in hand, was the essential qualification for local chapters. But we had only two members in Pittsburgh, where some persons outside of our Society suggested that we form a local chapter.

Mr. W. H. Bryan of St. Louis, a member of our Society, corresponded with us last April, with a view of exchanging papers with the Engineers' Club of St. Louis, and he suggested that they were corresponding with all of the different engineering bodies, with a view to having them send their papers to be presented at their annual meeting to the Engineers' Club of St. Louis, to be criticised, or read and spoken on, and that the discussion if approved by our editor, was to be included in our Proceedings. He said that they also could present papers to our Society, and if approved by our Publication Committee, they were to be presented at our meetings. That did not seem to meet the approval of the Board of Governors. I had a further letter from Mr. Bryan, dated July 13th, urging that the Society consider St. Louis for a place of meeting for the next summer meeting, which, as I understand, by virtue of a resolution passed at Atlantic City last year, was virtually adopted. He is sorry that he cannot attend the convention, and requests to be advised what the general sentiment of the members would be in connection with the local engineers' club. He says here, "I enclose an extract from a letter from Chairman Johnson: 'The Board of Directors of the American Society of Civil Engineers have taken action upon the application of the St. Louis Engineers' Club's committee on affiliation, and have granted the request made as follows: They will furnish us with copies of all papers to the number that we may require, and in case our club discusses these papers, the discussion will

be printed in the transactions of the society, and a printed copy of the final, complete papers, with discussion, will be furnished each member of the St. Louis club, and ten copies to each of those taking part in the discussion. whether members of the American Society or not. All this will be done free of charge. Also they have granted us the privilege of receiving papers from the National body at our regular meeting, and have same appear later in the transactions with copies furnished to all our members as above described. This they do in the belief that it will increase the number and value of the papers presented to the American Society of Civil Engineers, and that it will not offer any inducement to members to withdraw from the National body; on the other hand, will probably result in largely increasing membership therein.' "

That presents the question before the Society just as we know it in the Board of Governors.

President Crane: This subject is open for discussion.

Mr. Smith: Do I understand that involves the proposition that some of the papers that are to be presented to this Society and printed in its Proceedings, are to be previously printed in the proceedings of some other body?

Secretary Mackay: No. I would say that in connection with this matter of local chapters, Mr. Snyder, the Vice-President of our Board of Governors, and Mr. Chew, a member of the Society who is largely interested, both of them being here, possibly may be able to give you some further views on the subject.

Mr. Snyder: Mr. Chairman and gentlemen, my mind has gone through a rather revolutionary stage on this question. When the subject was first brought forward it seemed to me that the formation of local chapters would be a good thing, but I studied the situation over and I have reached the conclusion that it would be a mistake, as the Society stands today. If in five years from now, or say another ten years, the Society should so increase in membership throughout the United States as to render it wise, I think, perhaps, then it might be well. But as matters are now and with, what I might say, the comparatively limited number of men who are eligible for membership, I do not think it would be a wise proceeding at the present time.

Mr. Kent: I entirely agree with Mr. Snyder in regard to the undesirability of establishing chapters. The Society is too young yet, and it is as yet too difficult for us to get the papers for our annual meeting to make a respectable showing in our volumes. I think it is spreading ourselves out a little too thin to attempt to get local chapters.

In regard to the application of Mr. Bryan in behalf of the Engineers' Club of St. Louis, I was a little surprised to hear that it had been refused by this Society and accepted by the American Society of Civil Engineers. I was also surprised that the American Society of Civil Engineers had accepted, and were willing to incorporate in the transactions of the Society of Civil Engineers, such discussions as might take place in the local society. I think that might lead to trouble hereafter. There may be some discussions that they would like to carefully edit before printing them. I think the transactions of any Society should be carefully edited before they are published, especially if the discussion takes place in another place and by a local society; but I would like to see the action of the Board of Governors taken up again, and see if they cannot make some sort of affiliation with local societies when they apply. It seems to me it would quite right for us to say to the Engineers' Club of St. Louis, that if they have a paper before them on the subject of Heating and Ventilation, that we would be glad to receive that paper and have our Board of Governors consider it, and, if the Board of Governors see fit, to authorize its publication in our Proceedings. Our Proceedings ought to be a reservoir of the best literature on the subject of Heating and Ventilation that can be-got in this country, whether it comes from our own membership or not, and that would be a very good way to increase the value of our Proceedings if we could incorporate such papers as might be presented by local societies. I think that would be a good thing for other societies to adopt too—to have such affiliation with the local societies that papers on certain subjects if read at a local club might be incorporated in the National Society's Proceedings. I hope the Governors will take that up again and see if some such arrangement cannot be made.

Secretary Mackay: I would like to say that the Board of Governors did not turn the matter down, but it came just as

we were considering the question of local chapters, and that question of local chapters was referred to the semi-annual meeting as a topic of discussion and will be taken up by the Board of Governors at the next meeting and considered. I wrote Mr. Bryan immediately after the May meeting that the decision of the Board of Governors was, that they would take no action on it at that time, and that it would be referred to this meeting, after which it would be considered by the Board again. I think the principal reason was, in connection with the adoption of local chapters, that it was perhaps a little premature and they wanted to get the opinion of the members of the Society present at the summer meeting, before they took any definite action in the matter. It was somewhat along the same lines, although a little different, and I wrote to Mr. Bryan that unfortunately, in the past, our papers had been received so late for our meetings that it was frequently impossible to get them to our own members in time to have them study them up for discussion before coming to our meetings, and unless we could get them sooner, it was impossible for us to get them in their hands in time for them to discuss them and have the discussion brought before the meeting.

President Crane: As the Chair understands, then, the Executive Committee desires this Association at this meeting to advise them relative to this matter.

Secretary Mackay: Yes. At the same time a majority of the members of the Board of Governors were decided on the question that we did not want local chapters in the present state of our Society and membership in the country.

Mr. Snyder: I would like to say, on the line Mr. Mackay has just been speaking about, that the Board of Governors seemed to feel so strongly on that point, that they did not want to finally clinch it without having it go back to the parent body, and be discussed a little more fully. Perhaps somebody might throw some new side lights upon the subject which perhaps would reverse their opinion.

Mr. Ashworth: I think that aside from the undesirability of creating local chapters, matters are now evolving themselves with the local societies so that it is not necessary. Now the Engineering Society of the City of Pittsburgh has become so large in membership, and covers such a multiplicity of

branches of engineering, that it is now divided up into sections, and that is the trend almost everywhere. Before a great while there will be a section devoted to this special line of engineering. Now as they gain strength in these local bodies, in these sections, so will be evolved men who are working upon this line of thought and manifest a disposition to bring out original matter and render themselves very worthy of membership in the National body, and their aspirations, it seems to me, following up that which they are devoted to, will lead them to make application to the National body. Local societies will have their own expenses, their own central organization, and from it these members who get into these sections will eventually increase the standard of membership and add to its dignity. I fear that the other way would rather detract from its dignity, and possibly have a tendency to disintegrate. I really think that it is a good idea not to take that step but let the sections work out themselves, and make application to the higher body, which is the National body.

Mr. Chew: So far, all that has been said has been along the negative line, and opposed to local chapters. I do not know that I am deeply interested in the formation of local chapters. I can see where a decided benefit would come, and I shall talk along that line for the sake of argument, rather as a loyal champion. Take the city of Pittsburgh, Mr. Ashworth says there are engineers there that have a section. That has no interest for us. That section probably never will have. Those members of the section will be loyal to their parent body, and occasionally we may find some good friend who will jump over the bars and come into our Society when he recognizes that we are devoted to the special industry that he is interested in. But it is to build up the heating industry and the better understanding of it in any locality. We are not doing much toward it when we discourage men who think that they would be benefited by some society in their midst. Pittsburgh is a large enough town to apply the broad feeling of generosity towards the membership that Professor Carpenter has expressed at different meetings. Pittsburgh, along these lines, can furnish, without any great difficulty, I should think, twenty-five or thirty men. If you want men of the stamp,

say of our past presidents, to say nothing of the lesser lights who are here on the floor, possibly you might not be able to get any more than Mr. Ashworth, or one or two others in Pittsburgh; but apply the broader rule, let men of smaller calibre, but who have ambitions and aims, in, I still think you can get twenty-five or thirty men from Pittsburgh now. As to the members there, they are not now greatly beneficial to this Society in encouraging men there to come into it, nor are they greatly beneficial in encouraging a higher standard of work, on account of their independent action, and those other men that should be members of our Society only get an idea of what should be done through the meetings in New York of the American Society. Now if there are men out there who are doing steam and hot water on the contracting lines, they design their own work, consequently they are engineers. Take those men who are modest in their claims as to their qualifications. They have a desire to improve themselves. They would like to meet together. They feel the need of an organization. They feel that some benefit can be derived from resting under the wing of this body. The recommendation here is that a local chapter can only be formed of men who are members of the parent body. If there is anything in association at all, those men will have a desire to come to New York or to send a representative to New York, to have some particular thing threshed over in the parent body which they took an interest in in their local chapter and in that way they will not only be a benefit to the Society by bringing questions to it that need to be discussed, but they will also benefit themselves. I think that having chapters will not be any detraction from the high standard which our Society is growing right along up to and is growing higher yet. In Philadelphia, for instance, we have a good many members, and there are a lot more men over there that could join a society that would be very reluctant to take the time away from their business to attend the annual meeting. So that I feel that local chapters conducted along the rigid lines of membership and application as laid down here, instead of being a drawback, would be possibly a means of recruiting our membership with good material, and our Society would be working on the broad liberal lines which Mr. Bates gave us in his first address. If it

is to be conducted along the lines of helping to spread engineering information, then the local chapter has a decided usefulness. (Applause.)

Mr. Switzer: Mr. Chairman, as the mover of the original motion which agitated this discussion at the annual meeting in New York—by request, however, I offered that motion—I would say that I have had an opportunity to confer with engineers in the heating and ventilating trade in remote sections in the far West and particularly the Pacific coast, the northwestern cities and the Rocky Mountain cities. There are some exceedingly bright engineers in those localities. Their work speaks for itself—equal perhaps to some of the most common systems that are installed in the New England cities. I fear that many of our members live in too small a sphere in the eastern cities and do not take into consideration that there are many engineers in the heating and ventilating trade located in the far western and remote sections of this country that would be certainly eligible to membership and would be a great credit to the organization. This matter has been discussed somewhat by those people in the trade press after having seen the account of the annual meeting last winter, and they hoped that it would be taken up and some favorable action would be considered by the Board of Governors, to whom this question was referred on my own resolution, along the line that while they, as members, could not attend these various meetings, yet they would feel inclined to become identified as members and to have quarterly meetings, for instance, in their respective sections, and when it came to the annual meeting, would delegate some one of their members to make the journey to our annual meeting in New York and take an active part, perhaps prepare a paper, but at any rate the most important feature that they considered was that this delegate would report back to them the proceedings verbatim and take up in heart-to-heart talks the different subjects discussed, whereby greater results could be acquired than by the report of the trade papers.

Mr. Switzer: I move that the matter be referred to the Board of Governors and further discussed and reported at the next annual meeting in New York. (Seconded and carried.)

Mr. Feldman: This is a topic that especially interests me

just at present. At Albany the local members of the American Society of Mechaincal Engineers in Schenectady, Albany and Saratoga, organized a local committee for the entertainment of the members of the American Society of Mechanical Engineers at Saratoga, and after the meeting there I proposed to take advantage of the members being together to organize a local chapter of the American Society of Mechanical Engineers. That matter was taken up very favorably, and after a long discussion it was broadened out into organizing a large society of local members of different cities including different sections of all the American societies, and a committee was appointed to prepare by-laws for such a society. I am one of the members of that committee and am corresponding with the American Society of Civil Engineers, the American Institute of Mining Engineers, and the American Society of Mechanical Engineers. I did not belong to the Society of Heating Engineers. Now the American Society of Mechanical Engineers, as perhaps you know, revised their constitution at the last Saratoga meeting and there was one section introduced to organize local chapters. In New York they have begun to meet already, and I hope in the fall there will be a local section organized in Albany, and undoubtedly there will be arequest to your Society to allow us to organize a local chapter of the American Society of Heating and Ventilating Engineers. It will probably be by the method of separate sections, the sections to meet together for financial purposes and for social purposes. Besides the American Society of Mechanical Engineers you probably know that the American Institute of Electrical Engineers, being one of the youngest, is the most successful and the most advanced, because from the beginning they have organized local chapters; they meet monthly and they read the paper simultaneously in every city practically in the country, discussing the same papers and bringing them up afterwards in the proceedings. They are so progressive that they have just organized besides this what they call the students' section. They have incorporated in their constitution that every college can organize a small section to be called a local membership and composed of students only, with the understanding that after they graduate they can become junior members and so on. If local chapters would be organized by members they will draw a great many

young people who will become interested in the subject and take it up as a specialty. But if you organize a local society you will have hundreds of men all over the country who will join those societies. There are a great many young men who are very ambitious—for instance who are steam-fitters; they might not be engineers, but might become associate or junior members, and they have some practical points which they can can teach theoretical men very often. I would be very much in favor of organizing such local chapters. I know in Albany there are several heating engineers who cannot go to these meetings who are narrow enough to say that once or twice a year would not be sufficient. Of course it is for the council or Board of Governors to organize or give by-laws. The papers delivered before the Society can be distributed all over the country and read simultaneously and discussed, and you will have a larger attendance.

Mr. Harvey: I may be all wrong in my ideas about this thing. Of course I did not think of the Society going into the kindergarten business, but I supposed that it was not going into the missionary field either. I thought that it might be a good plan for this Society to keep on its good work as far as it has gone. I think it would be wise to continue doing so for some time yet to come. I do not see any reason why societies of that kind cannot be organized among themselves in cities for their local information. I think it might be a good plan. But on the other hand I do not think that it would be a good plan to have them directly connected as local chapters, because if there are any good men, any men that are qualified, they can become members of the American Society just as well as not, and even if they cannot come to the meetings they can send the contributions of their talent whatever it may be. I think that you can overdo that thing, and I would advise just to go a little slow. I have seen a good many other societies arranged in that way with their locals, and they got so local that it spoiled the real benefits of the main society. That is the way that I would look at that point. I think it would be wise just to think twice before you go too far on that line.

Secretary Mackay: I would like to ask Mr. Feldman if the local associations of the Mechanical Engineers or Electrical

Engineers are formed from men outside of their body or from members of the body.

Mr. Kent: Members of the body.

Secretary Mackay: Then I want to say further that the Board of Governors considered that they had no right to father anything that they could not control and give it the name of the Society, and that the name of the Society should not be used by men outside of the Society, and so confine it to the smallest number that they thought would be effective in any section; and in canvassing our roll of members we found that there were three cities in the United States where that would be effective—New York, Chicago and Philadelphia, and since that action and this month we have taken in two members from Denver into full membership and one from Portland, Oregon, one from Vancouver, British Columbia, two from Pittsburgh, and a number from different sections of the country. We have virtually doubled our members from Pittsburgh since the question was under discussion and partially decided against by the Board of Governors, because we had only two members in Pittsburgh and we have now four. I would say that that matter was carefully and impartially considered by such men as Mr. Kent, Mr. Snyder, Mr. Gormly, Mr. Jellett, Professor Carpenter, and other men who have the interest of the Society more than any individual interest of their own at heart.

Mr. Feldman: The understanding is this, that there should be no branches organized which should call themselves heating engineers, but that there should be organizations of members of the Society in a city. For instance, if in Albany there are half a dozen members of the American Society of Heating and Ventilating Engineers, they should be allowed by the Board of Managers or Board of Governors to organize a local branch of the Society; they are already accepted and they could be allowed to organize as a local branch. Instead of meeting probably twice a year you might further develop into meeting three or four times a year, and instead of reading papers brought up at the time, copies of papers which were accepted by the Society can be sent to Albany, can be sent to Chicago and San Francisco, and those local members who cannot come here can take those papers which were to be presented and read them and discuss them there the same way as discussions

here are taken up and afterwards revised by the editor. It is not to organize new branches entirely of persons who may not be members and then they can become members of the American Society; it is to organize local chapters of the members of the American Society. There is no reason why three members of the Society cannot organize a local branch and discuss those subjects and either read papers of their own or get papers from headquarters and send papers to headquarters for acceptance or rejection. It is not the idea that any engineers or manufacturers should organize and become heating and ventilating engineers. First of all they have to be members of the American Society. That is the idea of the American Society of Electrical Engineers and the American Society of Mechanical Engineers. Of course I do not know how that would be done. The Board of Managers will have to devise that.

Mr. Cobey: The popularity of anything is usually its death. Take bicycling for instance. I believe that if the individuals are picked from the various cities throughout the continent, you can bring about the formation of a healthier body than by going into the matter of local organizations or chapters. I had a little experience in that line, and I find that if you organize locals in the various cities throughout the continent or in the several Americas, whatever it may be, they flourish for a time, when they desire to become districts. One man or two men probably would represent New York, another man would represent Yonkers, Newburg, Poughkeepsie, Kingston, Hudson and Albany and so on. So that they go back to the old borough system of legislation. They leave that which you are now talking of forming and go back to what you are practically in now. So that it is a matter of threshing out a lot of old straw in which there is no grain.

But coming back to the original proposition, the undesirability of forming chapters in the various localities, I would say that if a man from St. Louis presented himself for membership and was qualified to become a member, he would be desirable. If he was from Chicago, the same. Each man would feel interest enough to defray his own expenses. If you go into the local chapter arrangement, they will look to the parent body to contribute a certain amount of mileage in order to bring them to the point where the convention is held. There will be

ambitious men, who are not always qualified to act as heating and ventilating engineers, who will probably be able to sway influence enough to send them to that centre where the convention is held, and it will kill the very object that we are seeking to attain. I do not see where we would benefit ourselves by organizing local chapters and then electing delegates to a National or International body. I think that the Society has progressed very well in the last few years, and if it continues to do so in the next two years it will not need any local chapters.

Mr. Kent: Every young engineer ought to have two ambitions. The first is to become a member of his local engineers' society. In that society he gets acquainted with civil engineers, electrical engineers and every other kind of engineers, and studies all the local engineering problems, whether it is his particular branch of the profession or not. When the society grows big enough it comes to be divided into sections as Mr. Ashworth says, and that section may become a very valuable local society. The next ambition of a young man is to join one of the five national societies. If he is a heating and ventilating engineer he will join this Society. If he is an electrical engineer he will join the American Institute of Electrical Engineers. If he is old enough and broad enough perhaps he will join three or four of the National Engineering societies. But do not ask that young man to split himself up into too many different things; that is to be a member of his local society and a member of the chapter of the American Society of Heating and Ventilating Engineers. If he is very young and cannot get into the society and has not got the $10, let him join his own society in his own town and then later apply for membership in the National Society. This Society seems to have entered on a new stage of existence. Up to the present meeting it has been the effort of the society to increase its membership for the mere financial reason of getting enough money in to pay for publishing its Transactions and keeping it alive. We have already passed the crisis. We have already reached the stage when, instead of our hunting for members, men are hunting to get in, and that is a very comfortable condition, and I think we better let well enough alone and not be too enterprising.

Mr. Ashworth: Let us look at that section again. Here is a section of Heating and Ventilating engineers in a locality, say in Pittsburgh, and there are a number of young men, rising young men who are manifesting a very prominent disposition in this trend of thought; how natural it is for a man that wishes at heart the success and the power of his National organization to go to this young man and say, "My dear friend, you ought to be a member of this National body." I have done it for the American Society of Mechanical Engineers. I think it is all right for us to go on as a National body and encourage sections to produce the material that will help to build up this greater and more magnificent edifice.

### TOPIC NO. 6.

"The relative dimensions, weight and material in piping systems of different diameters working under a steam pressure of 200 pounds or over in pipes, fittings, flanges, gaskets, etc."

Mr. Smith: I have a paper here, Mr. Chairman, that one of our members, Mr. Barron, blocked out, and he asked me to present it. He asked me to fix it up as well as he would do it, but I have not done so.

### HIGH PRESSURE PIPE WORK.

In a paper recently read before the American Engine Builders' Association, by Mr. William Andrews, he states that:

"Pipes, fittings, pumps, engines and all material used in a modern first-class job are now required to stand a working pressure of 200 pounds per square inch.

"A modern high pressure job requires, first, a good design; second, good material; third, skilful steam fitters. The first requirement can be altered to suit the conditions, but the latter two, never.

"Superheated steam destroys and burns the valves, gaskets and other delicate parts, and we will probably have to start all over again."

It does not seem to me necessary to start all over again. The arts do not advance by making new starts but by following the law of continuous progress.

British and Continental engineers who have been working

on high pressure would be amused at the complacency of the American claim that we are doing all of the advancing. In my experience I have gone as high as 130 pounds, and I presume that the plants which are running to-day with a higher working pressure are exceptional. I believe that 200 pounds will be considered a moderate pressure. If work is designed as Mr. Andrews suggests for the 200 pound mark, I am satisfied that it will be all right for any possible degree of superheating and for a considerable advance in pressure.

I think that up to five inches of pipe can be merchant steel pipe and all fittings extra heavy, both screwed and made up without lead or graphite. From five to ten inches the pipe should be extra heavy, screwed with standard cast-iron flanges, flanged fittings and copper gaskets. From ten inches to sixteen inches should be extra heavy pipe with welded flanges and copper gaskets. Above sixteen inches, double extra heavy with riveted flanges and copper gaskets.

Expansion to be provided for is a problem that can only be considered in each specific case, and as the piping gets larger, the problem becomes more serious. On that point the writer referred to is not specific enough to suit me, as he says:

Allowance for contraction and expansion is provided for by long bends, by using a double swing (like a gas bracket) on which the fittings turn on the threads of the nipple and by producing what may be called initial tension; this can hardly be described in words, but it is a rule-of-thumb method, by which the skilled steam fitter puts a strain on the pipes when cold so that when the pressure is put on the expansion removes the tension and there remains no strain on the pipes other than that due to internal pressure; expansion joints of the old slip style or those made of corrugated copper have entirely disappeared from the first class job.

Offsets and bends seem to be the only way to provide for expansion, and high pressure piping can be generally planned so that the danger due to expansion is minimized. The proper way to discuss this subject would be to have a specific design of piping, but that is out of the question, as, while most engineers are willing to have any other design of theirs discussed, on engine piping they want to talk generally, and generalities are perhaps the best after all.

Mr. Kent: I would like to ask if any member has any figures on the amount of expansion that can be taken up by a bend of 180 degrees of steel pipe of a different diameter and different lengths of legs. I have not seen any such figures. The problem is a practical one coming up all the time. We want to use bends of 180 degrees or more with long legs to take up expansion. The question is, how much expansion can be taken up by a bend without straining the pipe beyond the elastic limit, or without introducing any danger of any kind. I would like to know if anyone has any data on that subject.

Mr. Feldman: This question has interested me very much. I have been trying to investigate it myself. I had a case like this to design. I designed a bend made of 180 degrees of a full 20-foot pipe, 8-inch pipe. At the ends I put in short bends, connected them with a Walmanco joint, made by Walworth, and then at the end with ordinary joints. I wrote to the manufacturing company who made the joints, asking them where they had the experience. Their engineer at one time answered me that you could allow two inches for that expansion. Another answer was that if we want 70 or 80 pounds pressure, you can allow two inches for 100 feet. So that it seems to me that even the manufacturers who were making these pipes do not experiment, or are afraid to give us the data. I am going to have these data within a few months, because I have installed a plant like this.

Mr. Kent: I want to find out whether the pipe has been overstrained by the expansion—too much strain on it.

Mr. Feldman: If it has not passed the elastic limit—if there is no permanent set, there would be no excessive strain.

Mr. Kent: How are you going to find out after the pipe is in place?

Mr. Feldman: If you measure the difference, when it is hot and when it is cold.

Mr. Kent: It will take the position which the expansion compels. You cannot tell whether it has been overstrained. It may expand and contract all right, but in doing it dangerous strains may be brought on the metal, and after awhile you will have ruptures.

President Crane: I have had some experience in this line lately, and this week we will make a test on a plant where in the

working pressure is 175 pounds with the steam superheated to 150 degrees. The plant consists of 24 boilers, 500 H. P. each, and three 5,000 kilowatt turbines. The header is in the basement, about 18 feet from the top of the boiler. There is a fire bend on the boiler leads at the top, and also a bend into the header at the bottom, with 18 feet of straight pipe between them arranged in this manner for expansion. From my experience in connection with high pressure and superheated steam work, I hardly expect any trouble from strains on these connections, but when the connections are short and made with but one bend there is where the trouble is met with. The work I have in mind is well arranged and provided for with bends and long intervening lengths, so there should be no trouble The header connects up eight boilers, is about 150 feet long, and is supported on brackets riveted to the columns of the superstructure of the building. This header is anchored rigidly near the turbine, compelling the expansion to be taken care of by the long boiler leads, and it does it perfectly. There is a header for each turbine and eight boilers are connected with a 6-inch lead from each to a header. The headers and all high pressure piping 6 inches and over is made with wrought iron flanges welded on to the piping. After welding these flanges are turned off in a lathe, with raised faces. The raised surface is about ⅛ inch and occupies all the surface inside the bolt circle. The fittings and specials are made of gun metal with raised surfaces, and the joint is made by grinding each surface true so as to make a steam-tight joint without the aid of a gasket of any kind. We grind this joint with corundum, and do not pass them until a straight edge laid across the flanges comes true, so that absolutely a perfect joint is secured. Before bolting up our joints we lubricate the surfaces with boiled oil, being careful that no grit or dirt is on the bearing part of the flanges. All headers and each and every line is tested and must be tight with 350 pounds of hydrostatic pressure. I am satisfied that those ground joints will be absolutely tight under pressure and superheated steam. In one small job we erected with these joints, which run from two inches up to sixteen inches, we had 180 joints, and there was not a leak on them at 200 pounds steam pressure, and we have news that the plant has had no leaks after a year's test.

Mr. Kent: Can you give us the figures in your experience, Mr. President, of the dimensions of pipe; that is, whether they have been smaller than pipes calculated for ordinary 100 pound steam?

President Crane: Yes. While I erected the work, I am simply working under instructions from the engineer. I will give you a general idea. With a boiler of about 500 horse-power, they run a 6-inch pipe from it, to a 5,000 kilowatt turbine, they run a 14-inch pipe or header. In our straight lines of pipe we use extra heavy, but in all of our bends we find best results from the use of standard pipe. We do not bend the extra heavy pipe at all. The idea, of course, as you see, is because of the expansion and contraction being greater in the standard pipe than in the extra heavy. This standard pipe will stand the pressure because all those bends that are made for us are tested to 700 pounds hydrostatic pressure before they are erected. That also is the test that is given on the welded flange work. The welded flanges are made of mild wrought steel and are made about the same thickness as any of the standard extra heavy stuff. The size of bolts, bolt holes and bolt circles are the same as adopted at the manufacturers' conference and known as "The Crane Company's standard" in the West. I have erected some six or eight of these jobs wherein we have used ground joints, and am prepared to say that I believe it to be the most thorough and substantial construction when high pressures and superheated steam is used. The grinding must be done carefully and consume much time, therefore is expensive. I have found that the average cost of grinding one flange is about $2.36.

Mr. Galloup: I would like to ask Mr. Crane a question, please —if these flanges are first turned off in a lathe after being fastened to the pipe, if they are turned in a lathe and ground in a machine, or if it is done by hand?

President Crane: No. The manner in which they are made is this: They are put on after the pipe has been bent, which insures accuracy. The facing is done after the flanges are welded to the pipe and they come to use with a smooth tool finish only. I have experimented with many devices of my own and other people's conception to grind these joints to a true surface with power, but have failed to get the desired

results except through the medium of a cast iron plate made with a raised surface, somewhat larger in diameter than the surface, operated by two sturdy men. I have not, however, despaired of constructing a machine to do the work.

Mr. Feldman: Does the Crane Company weld them?

President Crane: The Crane Company welds them. The Crane Company and the National Tube Works are the only ones I know of that do this welding. There are other flanges. I am no advocate of any special flange. There are other flanges in the market that probably are just as good. I have not had experience with them. It happened that we have had more of this kind of work than any other.

Mr. Dean: I would like to ask if anybody has a formula for figuring the breaking strain of the different pipes of the different sizes and different thicknesses.

President Crane: Mr. Kent, do you know of any formula?

Mr. Kent: Do you mean from the steam pressure inside? The ordinary formula for cylinders given in all the pocket books and engineering books—that is all that is necessary—the same as for boilers.

## TOPIC NO. 7.

**"Is there any reliable short rule for approximating the cost of pipe and fittings per hundred feet of surface in heating systems, also the cost of labor?"**

Mr. Kent: I heard Charles T. Porter once give a rule for proportioning the bed-plate of an engine which I think would apply to this: "Take all the formulæ you can get, figure out how heavy the bed-plate can be, then multiply by four, then add as much more pig-iron as the customer will afford." I think that the cost of 100 feet of pipe is something no fellow can find out until he has tried it, and then after he has tried it he will find the next case costs more.

Mr. Cobey: Mr. President, I find in my experience in the particular class of work that I am in that if I put up $150 worth of pipe and fittings, I add $100 worth of labor to it. That has been a rule that worked out very successfully and completed the work and there has not been anything lost on it.

Mr. Kent: On that same line I had occasion to call for a bid lately on some material, piping, erecting and all, and the pipe-fitter told me that his estimate for the material was 66 per cent.

and for the labor 33 per cent. That is, the material cost just twice as much as the labor in his estimate, and he was the highest bidder. I don't know what the other men figured; but they were a great deal lower than he was. In that case certainly labor did not cost more than 50 per cent. of the material.

Mr. Cobey: Of course we are obliged to pay the prevailing rates. Contractors, you know, can take advantage and hire a steam-fitter and five helpers. I was obliged to hire the steam-fitter at steam-fitter's wages and one helper.

Secretary Mackay: I think that perhaps Mr. Kent's work applies to power work where they can use up a good deal of material in a short time. I think if you come down to house heating work, which this particular topic applies to, that the labor comes nearer to being the cost of the piping and fittings than it does to any percentage less than that. That would be the experience of the average man in doing contracting work, steam and hot water heating.

President Crane: I would say for the benefit of the gentlemen that the system in the West is to base the labor upon the number of radiators to be erected. The system in my office has been such for the last thirty years that I have the cost of all of the pipe and fittings, the cost of every hour's labor and the number of radiators and the square feet of surface on each direct or indirect job, and my recollection is that it runs from six to fourteen dollars per radiator for pipe and fittings, not considering valves, and from one day to two days and a half for direct and indirect jobs. Now you can take your choice if you want to. You do not know where you are when you go to take rule of thumb. The only way that you can absolutely get at it is to lay a plan down and to put your rule on and then add a small percentage for what you have forgotten or missed.

## TOPIC NO. 8.

**"The effect of humidity on the load on warm air heating systems."**

Mr. Chew: I shall have to confess being guilty of proposing that topic. It was suggested by a personal experience in my own house, heated with a hot air furnace. I find oftentimes on winter evenings sitting alongside of a lamp to read, that I feel sort of chilly. I have no water-pan in the furnace, con-

sequently there is very little humidity in the atmosphere. Feeling chilly I have fired up the furnace and found that I had headache and found that the thermometer was up to 80 or 84. I think the chilly sensation I had was due to the air being so dry that it was evaporating moisture out of me. A year or two ago I decorated my house with a wire in the base-board forming a flat top arch. There was a floor register. I had a little pan that held about three pints of water. I took a towel and hung it over that wire and let the ends dip in the water. Whether it made any difference in the amount of coal I burned I don't know, but I certainly felt more the cooling effect without that humidifying device than I did when I had it in operation. I simply state that as my personal experience. That is the reason I suggested this topic for discussion.

Mr. Oldacre: I do not want to seem too critical, but I believe that the question should read a little bit differently; that is, instead of the effect of humidity on the load on warm air heating systems that it might have read "the effect of increasing or decreasing the relative humidity of the air with a warm air heating system." However, as regards the question as it is stated here, it is one that is comparatively easily answered. The greater the humidity of the air the greater the load. That is to say, if the air is taken into the heater at 80 per cent. relative humidity with the thermometer standing about 4 above zero and the air is warmed to 140 degrees, there is about the amount of heat required to heat the air itself, and to heat the water contained within the air is about in the relation of 4 to 1, that is, 25 per cent. of the heat is required to heat the water that is in the air and 75 per cent. to heat the air itself, and the higher the humidity of the air the greater the amount of heat that it is required to heat the air with the contained moisture to bring it up to the desired temperature. It simply means that to heat water is to do work. But if the question should read the effect of increasing or decreasing the relative humidity of the air with a warm air heating system then the question would become an entirely different one—simply due to the fact that with a reasonable relative humidity, that is, any place from 30 to 50 or 55 per cent. relative humidity, the heating effect, that is, the

sensible heating effect, is greater than if the relative humidity should run as low as 15 or 20 per cent., simply due to the amount of heat that is taken up from the fire.

Mr. Kent: In regard to the relative amount of heat required to raise the temperature of dry air and of air containing moisture, I find in a table of properties of air that a cubic foot of air at 32 degrees Fahrenheit, saturated with water vapor contains .0802 pound of air and .0003 pound of water. Taking the specific heat of air at 0.24 and that of water vapor at 0.48, we find that to raise the temperature of the air 1 degree Fahrenheit requires $.0802 \times 24 = .0192$ B. T. U., and to raise the water vapor 1 degree Fahrenheit requires only $.0003 \times .48 = .000144$ B. T. U.; and the heat required for any greater rise of temperature would be in the same proportion. That is, the air requires over 133 times as much heat as the small amount of moisture contained in it when saturated at 32 degrees.

Mr. Chew: I would like to call on another man here who knows something about humidifying air—Mr. Schaffer of Pittsburg. If I remember right, when natural gas was brought into use in heating houses in hot air furnaces, the continual maintenance of uniform temperature by a hot air furnace made it necessary to do something to save the pianos and other furniture from cracking, and Mr. Schaffer thought that he could make some money by producing something for that purpose, and he had the temerity to do it. So I think he ought to be able to give us some hints on that subject.

Mr. Schaffer: Mr. Chew is quite right. When natural gas was introduced in Pittsburg, natural gas was sold by the house, you might say; in other words the gas company simply sent a representative to see the building and he would say to you it will cost you $30 a year or $40 a year or whatever the man thought was right for a certain building to heat that house irrespective of how much gas you burned. The result was that everybody tried to burn all they could to get even with the company for what they were paying, and in doing so they ruined the furniture in the house and everything else. At that time I was, as Mr. Chew says, rightly, in the furnace business, and seeing the bad effects of the dry heat, the extreme heat

they were making, I introduced a vapor pan, an annular vapor pan that was placed in the furnace just above the feed door and the lower casing—it rested on the lower casing, and the upper casing rested on it, making the upper casing about six inches wider than the lower so as to leave the opening of the pan or the top of the pan inside of the casing. And this pan had a sort of a chute on it to pour the water in, and the pan answered all the purposes of moistening the air and bringing it to that state that it did not destroy the furniture anyway near like the other dry heat did. It became so regularly used there that there was hardly any furnace sold for a while without a pan, although afterwards the gas companies changed their tactics and sold gas by metre. That changed the tune of burning fuel and the moisture did not become so necessary. But that pan did certainly do the business.

President Crane: Probably your pan occasioned the gas company to make a change and charge by metre.

Mr. Schaffer: No, I do not think it was that. They saw what they were up against and changed that; but a certain amount of moisture is a very good thing if you can get people to take care of it.

Mr. Oldacre: In line with Mr. Chew's experience I can say that I have had some little practical experience of the necessity of increasing the relative humidity of the atmosphere in an enclosed space or the rooms in which we live. Some few winters ago one of our concern expressed the idea to me that he would like to have the atmosphere made a little moister, as he called it. He has a pipe organ in his house, and when the air is very dry there are certain tubes that will not respond and as soon as the air becomes moister those tubes will respond. Those are the bass notes, and by making an arrangement which consisted of a series of pans enclosed in a square box or a long box, a rectangular box with five pans in it holding about eight gallons of water and exposed to the action of the air, that travelled over the water about eleven square feet of surface, we were able to raise the humidity of the air by actual test about eight degrees, and as soon as we did that he was able to operate his pipe organ.

Mr. Schaffer: I would like to add to what I said about the use of these pans that I had any number of people who told

me that they could tell when the pan was empty just by the feel of the heat in the rooms without going to the furnace to see.

## TOPIC NO. 9.

"The relative importance of grate and heating surface in proportion to exposed surface in furnace heated buildings."

Mr. Chew: I shall have to confess, Mr. President, that I cannot answer the question. The furnace men have heated houses for countless ages—well, probably not that, but for a long time, but they have been apparently too busy to record their experiences. But, so far as I know, there are very few data accessible that can be applied to this question. Talking to Professor Carpenter some time ago, he was delighted with the plan that I had to develop some information along these lines, and the topic is presented by me more to arouse in our members a desire to go into their work in detail, take such measurements as would place in the hands of the Society the very data that now it lacks. If there is anybody that has information along the lines suggested I hope they will give it. There is no question in my mind but that the grate surface and the heating surface in a hot air system bear a relation to the exposed surface in the building to be heated as in steam and hot water heating. The steam and hot water heating trade have men who keep a record of the work so that such data are available in respect to those systems.

Mr. Kent: I would like to ask Mr. Chew if he has developed any plan for collecting that information?

Mr. Chew: About a year ago we printed a table in our paper called a "Furnace Work Record," and there were quite a number of people that responded. When I say quite a number I would say about two or three per cent., which is a big percentage to take an interest in a subject that you bring up in a paper.

Mr. Kent: Can't you publish a paper on the subject at the annual meeting?

Mr. Chew: Yes. I had not thought about that. I simply can revive those tables for the benefit of the Society.

Mr. Switzer: Along that same line a paper that was read at the annual meeting in New York last January regarding hot

air heating contained a number of data and specific observations in regard to wall surface, glass surface in proportion to heating surface and grate area. After that paper was read Mr. Kent requested that the data be tabulated in order to arrive at some definite conclusion without disseminating the entire paper. I was just looking through the record of the annual meeting to discover the data which were furnished to the Secretary, but I find that they are not in the record; he has them at the office. I trust that the discussion of this topic at this time will be the means of bringing out these data, the relative sizes of the grate areas in proportion to the radiating surface and the capacity.

Mr. Oldacre: As I understand this question it would really mean which is the most important to consider in connection with cooling surfaces of a building, the grate surface or the heating surface. That being the case I should think that it would be the most important thing to consider the heating surface and next the grate surface, simply in view of the fact that anywhere from two pounds to eight pounds of coal may be burned per square foot of grate surface, so that the first question would be the heating surface required to take up the heat that is generated. Then the question would revert back to the hourly consumption of fuel per square foot of grate surface. As regards the value of heating surface, etc., and the relation of that to the grate surface, the German engineers have taken up this question very seriously and threshed it all out, and it is wonderful that American heating engineers do not know more about what they have done. There are any number of experiments that have been carried out and tabulated and laid down as an absolute starting point. Professor Reitschel gives it in his book. Haas gives it in his book in a very elaborate form—the question of transmission, the question of radiation, the question of convection. Wolpert also gives it, and a little handbook, Kleiner's handbook, gives all those things just as much as tables of inches and feet and square inches and square feet.

Mr. Chew: When I ask a question I am perfectly willing that a man should take any view of it he likes as long as the information comes out, whether it comes from German books or from actual American experience, which I am inclined to

think is different. Maybe the German standards might have to be changed a little to conform to our practice, or they might have to use "the factor of ignorance" in applying the German data to American work. But if it has the effect of arousing some interest in the Society toward a collection of that character of data which will eventually enable formulas to be made simpler than those infinitely laborious German formulas, then the topic will be satisfactorily dealt with.

Mr. Kent: There was a book published by the Metal Worker, I think, some ten or fifteen years ago, giving some illustrations of house heating by hot air and the formula by which the apparatus was calculated. I believe Mr. Chew might refer to that and bring that into his paper.

Mr. Chew: I do not know that we want to go back to 1883 or 1884.

Mr. Kent: I think it was pretty good stuff.

Mr. Chew: I am glad to admit that it was good stuff, but I see no reason why we should not have more come along. Not only that, but as a result of some things that have been discussed in the Society, throughout the United States there is much more lively interest taken by the furnace men in arriving at a system of designing work than previously. Men can heat houses on a rule of thumb basis, and have been doing it for years. Now, if they will be systematic in determining what they need, there will be less failures, there will be less annoyance to people who have their houses heated.

Mr. Kent: I would suggest that Mr. Chew obtain from the furnace builders blue prints showing the shape of their fire-pot, that is, the dome above the fire-pot. Nobody can tell how many square feet of heating surface there is in a fire-pot by looking at these cuts. If we could have that we could get a good deal of valuable information.

Mr. Chew: I would just as soon attempt to do that as not, but I know the answer would be: "It is none of your business." The furnace manufacturers in the first place have very little knowledge of the work of installing furnaces. They make the furnaces to sell. Well, if it is worth while to have the thing, our furnace members who are installing work will have to measure up their furnaces and give us the surface approximately. Different types of furnaces can be taken, the

straight draft furnace with a combustion dome and the pipe to take the heat up the chimney, and then we can go on several different types of furnaces that can be considered along those lines. Then there is no doubt but what the Society will get something.

Mr. Switzer: I want to confess to Mr. Chew that, as a rule, with many of the manufacturers that are making furnaces it is only a small part of their business; it is a side-line. Some of them are greatly wrapped up in stoves and care very little about furnaces.

In regard to this topical question, as I read it this morning, I was under the impression that it referred the proportions and the relative constructions of grate areas, fire-pot capacities and radiating surfaces and the particular type of apparatus or certain diameter of casing, and, accordingly, along that line I have made some figures on some methods that I have adopted for a good many years in the manufacture of heating apparatus, but I find after Mr. Chew stood sponsor for that question that the calculations I made were not applicable to the way he put the question, inasmuch as he refers to the exposed surface in furnace heated buildings. If he had left off the question of heated buildings, exposed surface and furnace heating, it would have applied to the data and figures that I had in mind in arriving at the conclusion of the amount of radiating surface that the furnace should have in proportion to certain measurements in its fire-pot and grate areas. In our own practice and experience, not only in manufacturing and designing the apparatus, but as well in the installation of it in many sections of the country, climate and fuel conditions being taken into consideration, we have found that by multiplying the diameter of the fire-pot by the depth of the grate we arrive at a certain number of square inches. Dividing that by twelve we ascertain about the square feet of radiating surface that could be constructed in this furnace above the fire-pot to carry off the radiation, and the fuel consumed. In regard to the importance of the grate and the fire-pot areas, as far back as 1884, I was specially interested in making inquiries from the pioneer manufacturers of that day how they arrived at their capacities of certain sized furnaces. At that time it was all by the diameter of the casing.

In more recent years it has come down to the question of what is the size of your fire-box. As I stated, in 1884, looking for data and information at that time, I was surprised how little real information they had on the subject and that there was no scientific or specific rule that they followed in arriving at the capacity of their apparatus; that they took dimensions and proportions in accordance with many of their competitors, and in some instances they had been able to have, under favorable conditions, their furnaces installed, so that the result exceeded their statements and claims, and in many other instances they fell far below. But in my own experience and observation I was determined to have some definite specific rule to follow in regard to construction and proportions, and I must confess that while many of the manufacturers of furnaces are wrapped up and absorbed more with the commercial and the financial part of their business than they are with the technical part, it is a fact that they depend largely upon the mechanic to get results, and this question was brought up by the Committee of Tests at a meeting held in New York in May. Professor Kinealy, chairman of that committee, was very desirous of having this question of relative proportions of grate areas, fire-pot capacities and radiating surfaces brought out to make a report at the next annual meeting, and arrangements to that effect were put on foot, and it was regretted at the time that we did not have some means to make definite tests in various types of apparatus and arrive at conclusions so that we could have the records of this Society show absolutely the proportions necessary to acquire certain results as regards radiating surfaces in furnace construction. While the various types of apparatus would have to be taken into consideration, yet the committee would not undertake to recommend any particular type, but would show by absolute tests and demonstrations a certain device and the results that had been achieved in their tests, and Professor Kinealy has this matter very much at heart with other work that the committee has before it. It is expected that at our next annual meeting some report will be made along this line which will give some information which may be considered which is unknown to the members of the Society and to the craft at large.

Mr. Chew: Sometimes in preparing a programme I have known that a topic for discussion has been presented in a form in which you can either answer it yes or no. These questions are put on this programme for the purpose of bringing out information, and it does not make any difference whether the man who had the topic in mind gets the specific information which he was seeking, or whether some equally valuable information is brought out. In reference to this suggested test and the relative proportions—what is the use of wasting any time with the Committee on Tests? Mr. Oldacre is heating houses; he can measure up his furnace; he can say there is so many square feet of surface and the grate has so much area and that the building has so much wall surface and glass surface, and that is a record. When he talks of a church building, the grate and the heating surface and the cubic contents are so and so. Put that on a wire file and we will have something. Mr. Schaffer has been using another type of furnace giving pretty good service. He can say that the grate area is so and so and the heating surface so and so. Then he can say in these buildings, churches, schoolhouses and fine residences, and apartment houses, whatever they may be, the areas are so and so, and then he will find there is one square inch of grate area to about $1\frac{1}{4}$ to $1\frac{1}{2}$ of glass surface in the average furnace heated house. We have Mr. Switzer who is heating houses, or his customers are. It is a simple matter for him to bring a blue print of a particularly fine house that has been well heated, and there are other members who can do the same thing. The practical test is the job that a man has paid for and is satisfied with, and is better than the test that our committee would give us afterwards. To come back to the original thought here, our members ought to remember that topics for discussion are to bring out information, and I think the suggestion I make about some of the men measuring up their work should prove beneficial. Someone says: "If I was to do that, it would take three or four hours, and if I did that on somebody's job I might get $150." You want to drop your selfishness. Read Mr. Bates's address to the Society, and he says engineers can't afford to be selfish. Another book says that "It is better to give than to receive."

Mr. Switzer: I heartily approve of Mr. Chew's statement. The idea of members of the Society submitting their experience is a capital one, and I do think that the Society should elevate itself to a standard whereby it goes on record through its Committee of Tests, which was appointed for the purpose of absolutely demonstrating and having data that are spread in our proceedings throughout the civilized world where our records go as being a basis to work on. While this great mass of information would be very desirable, yet we want the best out of it, and we want to tabulate it in concise form that will attract the attention of the engineers of the world and be a source of education to the members of the Society as well as those identified with the branches of heating outside of the Society. The mass of information should be simmered down to the milk in the cocoanut and get the highest state of the art as a part of the record.

Mr. Schaffer: I will be glad to help Mr. Chew out in anything I can do, showing buildings and things of that kind; but I do not believe that the furnace heating will be elevated to its proper place so long as the manufacturers are so indiscriminate in selling to everybody who comes along—any old wood butcher who comes along to buy a furnace, whether he knows or does not know anything about it. They send their particular goods into every little corner—which is certainly their business in one way, but in order to elevate the heating business they ought to discriminate in respect to whom they sell their goods.

Mr. Kent: I do not agree with the gentleman who just spoke. Any power boiler manufacturer will sell a boiler to anybody in the world who has the money to pay for it. It is utterly un-American and absurd to say that a manufacturer shall be restricted; he should be allowed to sell without restriction by trade unions or any other restriction. Power boilers are sold in this way with absolute freedom. Anybody can go to any manufacturer of a power boiler and buy his products. At the same time a consulting engineer wanting to buy a power boiler for a client asks the manufacturer to specify how much heating surface and how much grate surface it is going to give for a certain rated horse-power. That is the way a consulting engineer buys a boiler. Why cannot

the heating and ventilating engineer buy furnaces in the same way? If a man is going to heat a house he sends around to the furnace men and says: "I want a furnace to heat this house." The furnace man says: "We call this our No. 8. This is the size you need." Why can he not tell how much grate surface and how much heating surface there is? That is the way it is done with a power plant. Why cannot we do it with heating plant?

Mr. Schaffer: I think the difference comes in in this way. Whoever buys a steam boiler or power boiler will employ a man who is up in the installation of power boilers to install that boiler, and it is in the installation of hot air furnaces that so much of the bad work is done.

## TOPIC NO. 10.

"The relative value of fire-pot and other surfaces in hot air furnaces."

Mr. Chew: I was the sponsor for that question also, and the President awhile ago said that he hoped that the hot air end of the institution would be prominent at the meeting in January. We certainly cannot complain of the way the hot air question has been taken up this time. The point that is brought out now in this question that has not been covered before is that if you buy a furnace that is all grate and fire-pot and very little combustion chamber you will heat the building at the expense of your customer's coal. There is a happy medium in construction; you do not want to have too long a fire travel or too little. It was said the furnaces had been rated on the diameter of casing. Now that method of rating a furnace will be killed as soon as the information that is needed to answer what is suggested in these topics is furnished.

Mr. Kent: I want to make a suggestion to Mr. Chew, that he clear up a little trouble at the last meeting in regard to the shape of fire-pots. There was some discussion at the January meeting as to furnaces being conical, that is, the fire-pot being conical, instead of cylindrical; but whether it was flaring outward to the top or flaring outward to the grate is not quite clear. It may be in three ways, cylindrical, tapered toward the top or tapered toward the bottom.

Mr. Chew: I have my fire-pot built largest at the bottom,

so it will free itself. It also allows lots of air to come in, and the more air you get into the bottom of the fire the better the combustion is in the furnace. When it is built the other way the ashes sink to the bottom and very little air goes in.

Mr. Kent: What is the customary way of building it?

Mr. Chew: I think the more general custom is to slightly flare them from the bottom up so as to make them a little larger diameter at the top than at the bottom.

Secretary Mackay: I think the particular case that Mr. Kent refers to was some discussion by Mr. Wolfe and Mr. Lyman at our annual meeting, where Mr. Wolfe called the attention of the Society to the fact that fire-pots were made in some furnaces with a 30-inch pot, but coning down so that there was only an 18-inch grate. The pot was conical in form, thirty inches at the top and fifteen or twenty at the grate line.

Mr. Switzer: The great majority of furnace manufacturers at the present time are manufacturing their fire-pots as large as is consistent with the diameter of the casing, and casting them nearly straight, as nearly straight as it is possible to get them out of the sand, having a large grate area and proportion of the fire-pot in proportion to the grate, the diameter as well as depth. Experience has taught those manufacturers who have given this matter considerable thought and have investigated it, that with a fire-pot cast nearly straight the ashes were free and clear, and a certain amount of grate area, proportion of diameter and depth and deep quantity of coal will give a better result, more units of heat, than a shallow fire-pot with a small body of fuel. Many forms of apparatus have demonstrated that effect.

## CXVII.

## UNIFORM CONTRACT

PROPOSED BY

## THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS,

NOVEMBER 10, 1903.

AGREEMENT made 190

Between

hereinafter called Contractor and

hereinafter called Owner, Witnesseth:

FIRST. Contractor agrees to erect and install

in and upon premises

in direct accordance with the specifications of Architect or Engineer, and under the uniform general conditions of The American Society of Heating and Ventilating Engineers covering the installation of Heating and Ventilating Apparatus and Appliances in Buildings, which specifications and General Conditions have been identified by the signatures of the parties hereto.

SECOND. Contractor agrees to commence said work on or about the day of to diligently prosecute and complete same substantially ready for practical operation on or before the day of

THIRD. Owner agrees to pay to the Contractor for the completion of said work, in substantial accordance with the specifications, the sum of Dollars; said sum

to be paid in instalments as the work progresses, as follows:

but only upon certificates of the Architect or Engineer herein named, to the effect that the proportion of the contract price represented by the instalment asked for has been actually earned by work or materials of that proportionate value furnished by Contractor. per cent. of the amount shall be retained by the owner until the time for final payment, which final payment shall be made within after the Architect or Engineer herein named shall have certified that the work has been wholly completed and all conditions complied with in accordance with the contract and specifications.

WITNESS our hands the day and year first above written.

*WITNESS.* {

# UNIFORM GENERAL CONDITIONS

OF

# THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

COVERING THE

# INSTALLATION OF HEATING AND VENTILATING APPARATUS AND APPLIANCES IN BUILDINGS.

## *Qualification of Bidders.*

Bidders for this work must be responsible parties, regularly and practically engaged in

and able to show that they possess ample facilities for doing the work. They shall give, if asked for, prior to the execution of the contract, corporate security for the faithful performance of the contract. If such security is so required, the cost thereof, not exceeding one per cent. of the total value of the contract, shall be added to the contract price.

## *Drawings and Specifications.*

There are drawings to which the specifications refer, and which are to be considered a part thereof. They are approved by the signatures of both parties hereto and are numbered as follows:

Bidders must carefully examine the drawings and specifications, and if any change is deemed necessary in the details thereof to enable them to comply with the requirements thereof, or to erect and install a complete and operative plant, in accordance with the conditions thereof, they must embody in their proposal a stipulation for such changes, and a failure to do so shall be considered as an agreement on the part of the bidders that the plans and specifications as drawn will meet the

requirements called for so far as making the plant operative in accordance with the design. Bidders, however, will not be required to assume any responsibility for the design of the work.

Where sizes are not plainly marked on the drawings, the sizes for corresponding parts may be followed. When the dimensions are entirely omitted, it is understood that the dimensions, if not agreed upon, shall be settled by arbitration, in the manner hereinafter provided in the clauses relating to arbitration.

In case of discrepancies between the specifications and the drawings, the specifications are to be followed as to general methods and principle, and the drawings as to sizes and quantities.

If detailed drawings are furnished by the architect or engineer, they will be made in conformity with the general plans and specifications, and are to be considered as part of these specifications.

All drawings and specifications are to be the property of the architect or engineer. They shall be carefully used and returned to the architect or engineer at the time the final payment is made.

*Assigning or Subletting.*

The contractor must not assign, transfer or pledge the contract, or any part thereof, without the consent in writing of the architect or engineer. He may, however, sublet portions of the work, but only under contracts embodying these specifications and the drawings referred to therein, and will be held responsible for the performance by the sub-contractors as if the work was done by himself.

*Intention.*

The entire work provided for in these specifications is to be constructed and finished in every part in a good, substantial and workmanlike manner, and with reasonable and continuous speed, and in accordance with the full intent and meaning of these specifications and the accompanying drawings. Everything necessary for the completion of the work and the success-

ful operation thereof, whether the same is herein definitely specified, or indicated on the drawing or not, and including the smaller details necessary to a workmanlike job and not usually described in plans and specifications, is to be done and finished in a manner corresponding with the rest of the work, as well and as faithfully as though the same were herein specified or described and specifically provided for.

*Architect or Engineer.*

Wherever in these specifications the words "approved" or "approval" occur, the approval of the architect or engineer is intended; and wherever the words "architect" or "engineer" occur, they will be understood to mean the architect or engineer named in the contract, or his agents or employees; or in case of his death, removal or disability, the architect or engineer substituted by the owner to supervise the completion. Provided, however, that such substitute be a man in the active practice of and of established reputation in the profession of architect or engineer.

*Material and Workmanship.*

All materials and work shall be at all times subject to the inspection and approval of the architect or engineer.

All materials of every kind and description shall be of the best quality, unless expressly specified otherwise.

All work shall be executed in the most thorough, substantial, neat and workmanlike manner.

Contractor shall not unnecessarily encumber the premises with materials, but shall furnish necessary materials in ample quantities, and as frequently as required to avoid delay in the progress of the work.

*Alterations.*

It is understood that the owner shall have the right to make any alteration, addition or omission of work or materials herein specified or shown in the drawings during the progress of the work, and the same shall be acceded to by the contractor and carried into effect, without in any way violating or viti-

ating the contract; notice of such changes as affect the price or guarantees to be given the bonding company or bondsmen. If the contractor claims that such alteration, addition or omission entitles him to an extra allowance above the contract price, or if contractor claims that they cannot be carried into effect without relieving him from certain other requirements of these specifications, or the drawings, he shall at once, upon receiving the order for such alteration, addition or omission, notify the architect or engineer in writing, and he shall abide by the decision of such architect or engineer as to whether such alteration, addition or omission entitles him to an extra allowance, and if so, how much and as to whether they relieve him, and if so, to what extent from the fulfillment of other requirements of these specifications or the drawings, and such decision shall also be binding upon the owner. The owner shall also have the right to call for the decision of the architect or engineer as to whether such alteration, addition or omission entitles the owner to a deduction from the contract price, and if so, how much, and the decision of the architect or engineer on this point shall be binding on both the contractor and owner. It is understood that the owner shall in no case be liable to pay for extra work and materials, unless the same have been ordered in writing by the engineer or architect, nor shall the contractor be obliged to perform such extra work, or furnish such extra materials except upon such written order.

*Delay.*

Should the contractor at any time refuse or neglect to supply a sufficiency of properly skilled workmen, or of materials of the proper quality, or fail to prosecute the work with reasonable promptness and diligence, or fail in the performance of any of the agreements herein contained, and such refusal, neglect or failure shall be certified to in writing by the architect or engineer, then the owner shall be at liberty, after giving five days' written notice to the contractor of such certification, to provide such labor and materials, and to deduct the cost thereof from any money then due, or thereafter to become due to the contractor under this contract. And if the written certificate of the architect or engineer shall also verify

that such refusal, neglect, or failure is in his judgment so gross, or so long contiued as to necessitate the termination of the employment of the contractor for said work, the owner shall have the right to take possession of the work and of all materials, tools and appliances thereon, and to employ any other person or persons to finish the work, and to provide the materials therefor. And in case of such discontinuance of the employment of the contractor, the contractor shall not be entitled to receive any further payment under the contract until the said work shall be wholly finished, at which time if the unpaid balance of the amount to be paid under the contract shall exceed the expenses and damage incurred by the owner in finishing the work, or in consequence of the contractor's failure, such excess shall be paid by the owner to the contractor; but if such expense shall exceed such unpaid balance, the contractor shall pay the difference to the owner. The expense incurred by the owner, as herein provided, either for furnishing materials, or for finishing the work, and any damage incurred through such default, shall be audited and certified by the architect or engineer, whose certificate shall be conclusive upon both parties thereto. If, however, the delay of this contractor's work be caused by any act or neglect of the owner, or of other contractors (not sub-contractors of the contractor) or by the abandonment of the work by the employees of any of the above, through no default of the contractor, or from any other causes beyond his control, the contractor shall have the right, immediately upon the happening or commencement of any event or condition which causes said delay, to notify in writing the engineer or architect that he claims an extension of time on that account, in which case the architect or engineer shall decide whether any, and if so, what extension of time shall be granted by reason of such delay, and the decision of such architect or engineer shall be binding upon both parties.

Contractor shall perform all the requirements of this contract promptly, and with diligence, as the progress of the work shall require. He shall not hinder or delay other contractors, or interfere with their work, and they shall have equal rights on the premises for the performance of their work.

### *Care of Work.*

Contractor must use all reasonable care to avoid damage to cornices, walls, flooring, wood-work, or any other work in the building erected by other contractors. He must make good any injury he may have caused, and leave the work complete and finished in a neat and workmanlike manner. No cutting of joists, columns or framing or cutting and undermining of walls or foundations shall be done without the written consent of the architect or engineer. Particular care must be taken of all finished work, which work must be covered up and thoroughly protected from injury or defacement.

### *Removal of Rubbish.*

All refuse material that may accumulate during the progress of the work must be removed from time to time, as may be directed by the architect or engineer, and on the completion of the work, all rubbish must be removed, and all parts of the work must be carefully and thoroughly cleaned and left in good condition.

### *Rules, Permits and Responsibility.*

Contractor shall comply with all municipal ordinances, all regulations of municipal departments, all state and federal laws, shall obtain and pay for all necessary permits to carry out this work, shall give the proper authorities all requisite notice relating to his work, and shall indemnify and save harmless the owner against all penalties for violations of laws committed by the contractor or by his sub-contractors. Contractor shall assume all risk of accidents to his work during the progress thereof, and also agrees to indemnify the owner against all loss of property or liabilty for damage to life or limb, or property of others that may occur, owing to the negligence of contractor, or of his sub-contractors, or of his or their employees or agents, during the execution of the contract or extra work in connection therewith.

### *Insurance.*

Owner shall insure all materials delivered and work done to the amount of payments made by owner to contractor, and to

the extent of the actual insurance money collected by owner under such insurance, contractor shall be relieved from restoring work injured or destroyed by fire. All work not certified by architect or engineer for payment, and all tools, apparatus and material of every kind belonging to contractor, or subcontractors, or his or their employees or agents, used in the prosecution of the work, or on the premises, shall be entirely at the risk of the contractor.

### *Patent Devices.*

Contractor agrees to defend all suits, and to save harmless the owner against all costs, payments, decrees and expenses of every kind, for or by reason of any claims or demands whatsoever, for the use in connection with the work herein specified, of any patented articles, devices or systems, or for any alleged infringement of patents. Owner agrees that within ten days of receiving information of the institution of any suit against owner, notice will be sent to the contractor of the same.

### *Final Tests and Acceptance.*

There shall be a final examination or test (if test be specified) made by architect or engineer of all work done under these specifications, within thirty days after the contractor has in writing notified the architect or engineer that the work is complete and ready for regular use. This test shall be conclusive as to whether or not the requirements of the contract have been met, unless contractor or owner shall within ten days after being notified of the result request an arbitration, in which case each party shall appoint an expert and these two shall appoint a third, and a test shall be made by said experts, the decision of a majority of them to be final.

### *Payments.*

Payments shall be made as provided for in the contract, but no payment and no certificate of the architect or engineer during the progress of the work shall be construed as an acceptance of the work included therein, but the contractor shall be liable to all the conditions of the contract until the work is finished and completed and finally certified by the architect or engineer,

and such final certificate shall not be issued until the accounts for extra work and materials, and allowances for omissions have been rendered, passed on, and made part of such certificate. Before final settlement is made, contractor shall—if so required in writing—furnish to the owner, or to the architect or engineer, an affidavit of contractor that all persons who have been employed upon the work, or who have furnished materials for the work, have been fully settled with, so far as they have bona fide undisputed claims.

### *Rejection of Material.*

The architect or engineer shall have full power at any time during the progress of the work to reject any work or material which in his opinion is not in accordance with these specifications, or which is defective or unsafe, and may order such work removed, taken down or altered to his satisfaction. Contractor must remove rejected material from the premises with reasonable promptitude. In the event of the contractor's refusal to remove, take down or alter the work condemned by the architect or engineer, the architect or engineer shall have power to have the same done at the cost of the contractor.

### *Temporary Use of Apparatus.*

Should the owner desire any apparatus erected by contractor to be operated prior to the final acceptance of the work and payment therefor, such operation shall be at the expense of owner and at his risk, both as to wear and tear and casualties.

### *Arbitration.*

Wherever by these specifications any question is to be submitted to the architect or engineer, and he shall be requested by either party, in writing, to give a written decision upon the question, and he shall fail for five days after the receipt of such notice to give such written decision, either party may, in writing, appoint an arbitrator, and notify the other party who shall within five days after receipt of the written notice to that effect appoint another arbitrator, and the two arbitrators thus

chosen may appoint a third, and a decision of the arbitrators, or a majority, shall be binding upon both parties.

In the following cases also the parties may appeal from a decision as to a question of fact rendered by the architect or engineer to arbitrators similarly chosen, to wit:

In cases in which the architect or engineer shall certify as to the amount to be added or deducted from the contract for alterations, additions or omissions.

In cases where the architect or engineer shall certify as to the fact that delay or failure on the part of the contractor is so gross or long continued as to necessitate the discontinuance of his employment.

In cases where the architect or engineer shall reject any work or materials or order the same removed or altered.

In cases where the architect or engineer shall fail to certify as to the fact that the work is completed and finished in compliance with the contract and specifications, so as to entitle the contractor to his final payment.

In cases where the contractor or owner shall within ten days after being notified by the architect or engineer of the result of a test of the completed work, refuse to accept the result of the test as conclusive.

In all other cases the decision of the architect or engineer shall be final, it being considered by both parties essential to the speedy progress of the work that prompt settlement of such questions should be made.

In the above cases on which an appeal is provided for, if no appeal is taken, the decision of the architect or engineer shall be final.

## CXVIII.

## REPORT OF COMMITTEE ON STANDARDS: CODE FOR TESTING DIRECT RADIATION HEATING PLANTS.

### OBJECT OF THE CODE.

In this country it is customary for the owners of buildings to require that when a contractor installs a heating system he shall guarantee that the system will be able to create and maintain a temperature of 70 degrees inside of the building when it is zero outside, and further that the contractor shall agree that the system shall not be paid for until it has been tried and the guarantee satisfied by actual trial during zero weather. This works a hardship on the contractor, inasmuch as he is often required to wait a long time, sometimes until two winters shall have elapsed before he receives payment for his work. And in order that this waiting may be obviated, and that instead of the contractor agreeing to wait until the system is tried and its heating capacity actually proved during zero weather, your committee proposes that the heating capacity of direct radiation heating systems shall be determined by a test made in accordance with the following Code. In this Code it is assumed that the heating system shall be tested when it is warmer than zero outside, by an engineer or some other person competent to make such a test, and that if the test be made in accordance with the Code and shall show satisfactory results when so made, this test is to take the place of a test or trial of actual service during zero weather.

### BASIS OF THE CODE.

The requirements of this Code are based upon the assumption that when there is not a very great variation in the difference between the temperature of the steam or water in a radiator and the temperature of the air in the room where the radiator is, the heat emitted per hour per square foot of surface per degree difference between the temperature of the steam in the radiator and the temperature of the air in the

room, is a constant quantity; and that the heat transmitted through the cooling walls and windows of buildings per hour per square foot of surface per degree difference between the temperature of the air inside and that of the air outside of the room, is a constant quantity. It is probable that these assumptions are not strictly true, but the deviation from the truth is so small that for all practical purposes they may be considered as true, and it is also probable that we do not know the coefficients for the transmission of heat from radiators to the air surrounding them, or from the air inside of a room to the air outside of a room, with a sufficient degree of accuracy to enable us to calculate exactly what the transmission of heat in any given case will be. Further, as the object of the Code is to enable systems to be tested in comparatively warm weather, when it is probable that there will not be such severe winds as would prevail in zero weather, it is probable that the deviation from the truth in the assumptions as to the transfer of heat from radiators to the air in a room and from the air in a room to the air outside, are such that the tests made in comparatively warm weather will err, if at all, in such a way as to introduce a slight factor of safety, such as should be introduced any way to make allowances for the cold, high winds which usually prevail or which may prevail during zero weather.

On the assumptions made then, if we let T represent the temperature of the steam or hot-water in the radiator, t, the temperature of the air in the room, and $t_0$, the temperature of the air outside, we have

$$(1) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \frac{T-t}{t-t_0}=k,$$

where k is a constant quantity for each building and heating plant. And if, as is generally the case, t is to be 70 when $t_0$ is 0, we shall have as the expression for the value of k

$$(2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad k=\frac{T-70}{70},$$

From equations (1) and (2) we get

$$(3) \quad . \quad . \quad . \quad . \quad . \quad . \quad t=70+\frac{(T-70)t_0}{T}$$

Equation (3) enables us to determine the temperature, t, which should be maintained inside of a building when the temperature outside, $t_0$, is higher than zero, and when the temperature of the steam or water in the system is T. This equation assumes that the test is made with the same temperature of steam or hot water in the radiators which would be used in order to keep the air of the building at 70 degrees during zero weather. It is not desirable to have the temperature of the steam or hot water in the radiators during the test different from that which it would have to be under the guarantee of the contract under which the system was installed, in order to maintain 70 degrees during zero weather. This is so because experience and tests have indicated that the heating effects of radiators vary somewhat with the temperature of the steam or hot water in them; and, hence, the committee deems it safest to make the test using exactly the same temperature of steam or hot water in the radiators that would be used or would be allowed to be used, under the contract, to maintain a temperature of 70 degrees inside when it is zero outside.

As has been said before, it is probable that the amount of heat emitted by a given radiator per square foot of heating surface per hour per degree difference between the temperature of the steam and the temperature of the air in the room, is not exactly constant for all differences of temperatures, but when this difference does not vary through a wide range, it may be assumed that the heat emitted per degree difference of temperature per hour per square foot of surface, is constant and equation (3) has been deduced upon the supposition that the difference between T, the temperature of the steam or hot water in the radiators, andt, the temperature of the air in the room during the test, is not very different from what it would be when the temperature of the air inside is 70 degrees and the air outside is zero. Your committee is of the opinion that the difference between T and t during a test should not be greater than 0.8 of the difference between T and t during zero weather. That is to say, if a heating plant be installed under a guarantee that when the temperature of the steam in the radiators is 220 degrees a temperature of 70 degrees will be maintained in the building when it is zero outside, no test of

the system should be made to determine its heating capacity when the difference between the temperature of the steam in the radiator, 220 degrees, and the temperature, t, maintained in the building during the test shall be less than 0.8 of the difference between 220 and 70, or 120 degrees. This will necessitate that tests, to determine the heating capacity of systems, shall be made during comparatively cold weather.

For example, let it be assumed that a heating plant be installed under a guarantee to maintain a temperature of 70 degrees in a building when the temperature outside is zero, with a temperature of steam in the radiator of 220 degrees. Here we have the difference between 220 degrees and 70 degrees, the difference between the temperature of the steam and the temperature maintained in the room during zero weather, is 150 degrees. If now, a test be made and it be required that when the test is made the difference between the temperature of the steam in the radiator, 220 degrees, and the temperature maintained in the building, shall not be less than 0.8 of the difference between the temperature of the steam in the radiator and the temperature maintained in the building during zero weather, we have, that when the test is made, $T-t$ must be equal to or greater than 0.8 of 150 or 120 degrees. Assuming that the difference between T and t during the test is 120 degrees, we have that t shall be equal to $T-120$, of $220-120=100$. That is to say, the temperature in the building during the test shall not be greater than 100 degrees.

From equation (3) we have

$$(4) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad t_0=\frac{T(t-70)}{T-70}.$$

Putting in (4) the values of T and t in this particular problem, we have

$$t_0=\frac{220(100-70)}{220-70}=\frac{220\times 30}{150}=44.$$

That is, the outside temperature during the test would have to be 44 degrees in order that the temperature inside would be equal to 100 degrees. If now, the test should be made when the outside temperature were less than 44 degrees, the tem-

perature inside would be less than 100 degrees. In this particular instance, if the plant is to be tested during weather warmer than zero weather, it would not, under the provisions of the Code, be allowable to test the plant when the temperature outside is higher than 44 degrees.

As a second example let us assume that a hot-water plant is installed under a guarantee to maintain a temperature of 70 degrees inside when the temperature outside is zero, with an average temperature of the water in the radiators of 160 degrees. Here we have the difference between T and t during zero weather is equal to 160 – 70, or 90 degrees. Assuming, as before, that the difference between T and t during a test made to determine the capacity of the plant, shall not be less than 0.8 the difference between T and t during zero weather, we have that during the test, T – t must not be less than 0.8 of 90, or 72 degrees. If we assume then, that during the test, T – t is equal to 72 degrees, we have that t is equal to T – 72. And since T is 160, we have that the greatest temperature to be maintained in the building during a test shall be 160 – 72, or 88 degrees. From equation (4) we see that when T is 160, and t is 88,

$$t_0 = \frac{160(88-70)}{160-170} = 32.$$

If now, the test had been made when the outside temperature was greater than 32 degrees, the inside temperature would have been higher than 88 degrees, but according to the requirements of the Code such a test would not be allowable. If the test were made when the outside temperature was less than 32 degrees, the temperature inside would be less than 88 degrees, and such a test would be within the requirements of this Code. In other words, the rules of the Code say that when the average temperature of the water in the radiators of a hot-water heating system of a building be 160 degrees in order to maintain a temperature of 70 degrees in the building during zero weather, no test of the plant shall be made to determine its efficiency when the temperature outside is higher than 32 degrees.

The two requirements which are indeed the basis of the Code for testing direct radiation heating plants in order to determine their capacities are:

1. That during the test the temperature of steam or water maintained in the radiators shall be the same as that allowed by the contract to be maintained in order to maintain a temperature of 70 degrees in the building when it is zero outside.

2. That during the test the difference between the temperature of the steam or water in the radiator and the temperature maintained inside of the building, shall not be less than 0.8 of the difference between the temperature of the steam or water in the radiator and the temperature maintained in the building when it is zero outside.

The following table shows the maximum outside temperatures during which tests may be made under the requirements of the Code, in order to determine the capacity of a plant, and also the temperature which should be maintained inside during a test when the temperature outside is the maximum allowed by the Code.

TABLE 1.

| (1) Temperature of the steam or water in the radiators, as required by contract. | (2) Maximum allowable temperatures during a test. | (3) Temperature which should be maintained in the building when outside temperature is as given in column (2). |
|---|---|---|
| 160 | 32 | 88 |
| 180 | 36 | 92 |
| 200 | 40 | 96 |
| 220 | 44 | 100 |
| 240 | 48 | 104 |

This table shows that it would not be allowable under requirement 2 to make a test to determine the capacity of a heating plant when the temperature outside is higher than 44 degrees unless the temperature allowed under the contract to be maintained in the radiators in order to maintain a temperaure in the building of 70 degrees during zero weather be less than 220 degrees. But even when the temperature allowed in the radiators to maintain a temperature of 70 degrees in a building during zero weather, be as high as 240 degrees, it

would not be permissible under the Code to make a test for determining the capacity of the heating system when the temperature outside is greater than 48 degrees.

Your committee also deems it advisable to include in the Code, a third requirement as follows:

3. That no test to determine the heating capacity of a system, to maintain a temperature of 70 degrees in a building during zero weather, shall be made when the temperature outside is greater than 48 degrees, even although the allowable temperature under requirement 2 of the Code should be greater than 48 degrees.

The object of this requirement is so apparent that explanation is needless. It is evident that heating systems should be tested, if not during cold weather, at least during weather when the temperature outside is less than 48 degrees.

## REQUIREMENTS OF THE CODE.

When a direct radiation, steam, or hot-water heating plant of a building is tested to determine whether its heating capacity is sufficient to maintain a temperature of 70 degrees in the building when it is zero outside, the following requirements shall be observed during the test:

1. The temperature of the steam or water maintained in the radiators shall be the same as that allowed by the contract to be maintained in order to maintain a temperature of 70 degrees in the building when it is zero outside.

2. The difference between the temperature of the steam or water in the radiator, and the temperature maintained inside of the building during the test, shall not be less than 0.8 of the difference between the temperature of the steam or water in the radiator and the temperature to be maintained in the building when it is zero outside.

3. In no case shall the temperature outside be greater than 48 degrees, even although the allowable temperature under requirement 2 should be greater than 48 degrees.

4. The temperature which should be maintained in each room or each floor of the building during a test, in order that the capacity of the heating plant shall be efficient to maintain a temperature of 70 degrees in each room of the building when

it is zero outside, shall be calculated by the following equation:

$$t = 70 + \frac{(T - 70)t_0}{T},$$

where t is the temperature which should be maintained in the building during the test; T is the temperature of the steam or hot water in the radiators, and $t_0$ is the outside temperature during the test.

If the temperature of the building, or of a floor or a room of the building, during a test be less than the value of t given by the above equation, the heating system shall be considered as not sufficiently large to maintain a temperature of 70 degrees when it is zero outside.

### THE TEMPERATURE, T, OF THE STEAM OR WATER IN THE RADIATORS.

In the case of a steam-heating apparatus, the temperature of the steam in the radiator shall be arrived at by determining the pressure of the steam in the main supply pipe by means of a correct steam-pressure gauge and then the temperature, as given by a steam table, corresponding to the average of the observed pressures shall be taken as the temperature of the steam in the radiator.

Readings of the pressure gauges shall be made at intervals during the test of not more than 30 minutes.

In the case of hot-water heating systems the temperature of the water in the radiators shall be arrived at by measuring close to the hot-water heater, the temperature of the water in the main supply pipe, and measuring also close to the heater the temperature of the water in the main return pipe, and the average of these shall be considered as the temperature of the water in the radiators. If there be more than one supply pipe and more than one return pipe to the systems, the temperature of the water in at least two supply pipes shall be observed, and also the temperature in at least two return pipes; and the averages of the temperatures observed in the supply pipes and the temperatures observed in the return pipes shall be taken as the temperature of the water in the radiators.

The temperatures shall be obtained by thermometers specially made for the purpose of indicating the temperature of water in hot-water mains, or by thermometers placed in thermometer cups in the pipes. Readings of these thermometers shall be made at intervals during the test of not more than 30 minutes.

### THE INSIDE TEMPERATURE.

The temperature maintained in a building during a test shall be determined by taking observations of the temperature in different parts of the building on each floor.

When the building is only one story high, temperature observations shall be made on the first floor; when the building is two stories high, temperature observations shall be made on the first and second floors; when the building is more than two and less than six stories high, temperature observations shall be made on the first, third, and fifth floors; when the building is more than six and less than twelve stories high, temperature observations shall be made on the first, fourth, seventh, and tenth floors; and when the building is more than twelve stories high, temperature observations shall be made on the first, sixth, and eleventh floors, and on each succeeding fifth floor above.

Not less than three thermometers shall be used on any one floor for indicating the temperature of that floor. The location of the thermometers must be determined for each particular case, although it is recommended that one thermometer be placed in the coldest room and one in the warmest room of each floor. These rooms will usually be those having a northwest exposure, and those having a southeast exposure.

The average of the temperatures observed in any room during a test shall be considered the temperature of that room; the average of the temperatures of the rooms on a floor shall be the temperature of that floor, and the average of the temperatures of the different floors shall be considered the temperature of the building.

The thermometers used for determining the temperature inside of the building shall be all glass thermometers with the graduations on the stem. They shall be graduated to read to single degrees Fahr.

The thermometers shall be hung about four and a half or five feet above the floor, but not closer than two feet to an outside wall or window.

Reading of the thermometers shall be made at intervals during the test of not more than 30 minutes.

### THE OUTSIDE TEMPERATURE.

The outside temperature shall be obtained by taking observations on thermometers placed in the open air. Not less than two thermometers shall be used for determining the outside temperature, and they shall be hung so as to be shielded from the direct rays of the sun, and to be as much as possible in the open. They shall be hung so that the bulbs shall not come in direct contact with the wall of any building, shed, or fence. They shall be all glass thermometers with the graduations on the stem and shall be graduated to read to single degrees Fahr.

The average of the readings of the outside thermometers shall be considered as the outside temperature, $t_0$ to be used for determining, by the equation of requirement 4, the inside temperature, t, which should be maintained in the building during the test.

Readings of the thermometers shall be made at intervals during the tests of not more than 30 minutes.

Respectfully submitted,

J. H. KINEALY, Chairman.
HERMAN EISERT.
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